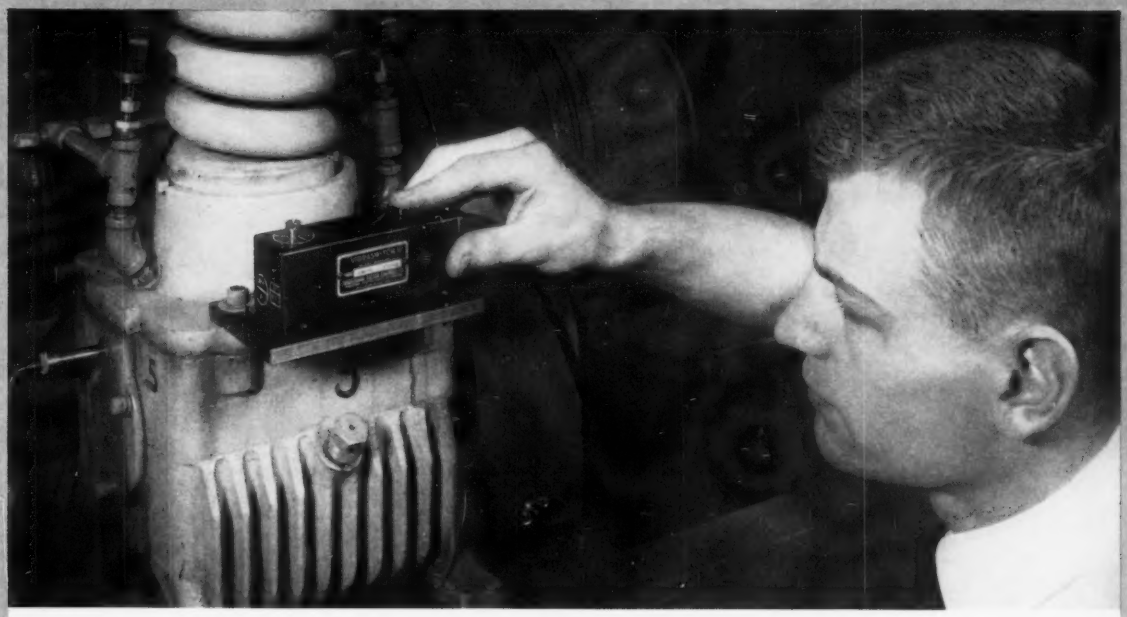
For engineers who design and manage the power and plant services

# Power

JULY 1958

ONE DOLLAR

A McGRAW-HILL PUBLICATION



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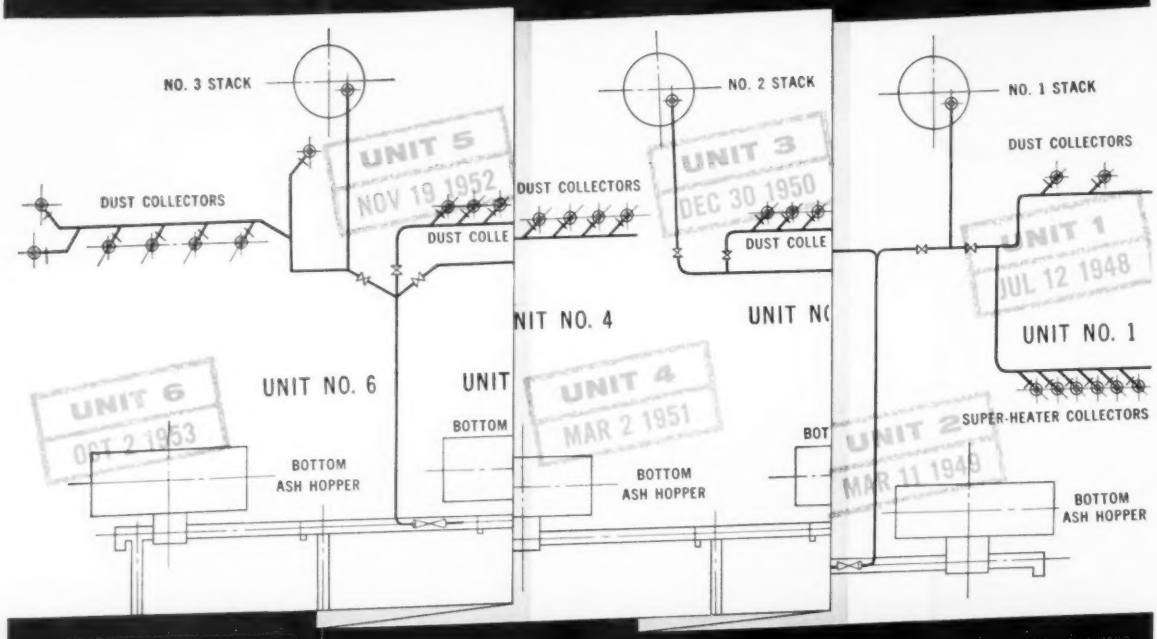
PROFILE OF PLANNED PROGRESS IN ASH HANDLING:

# A Unit a Year for Six Years




## at the O. H. Hutchings Station, Dayton Power and Light Co.

The ultra-modern O. H. Hutchings Station of the Dayton Power and Light Company is one of the most efficient generating plants of its type in the world. It was completed on a "unit-a-year" plan to meet the increased demands of more than 250,000 consumers in Ohio's Miami Valley.

Construction of Hutchings Station began in November, 1946; the first of six 60,000 kw generators went on the line just 19 months later. On October 2, 1953, the sixth unit went on the line, bringing the station's capacity up to the planned 360,000 kilowatts.

About 182 tons of ashes are removed daily by two Allen-Sherman-Hoff hydraulic ash handling systems, each serving three steam generating units. Bottom ash is sluiced to a sump and then pumped to a fill area; fly ash is collected pneumatically and discharged to the bottom ash sluiceway, then pumped to fill.

While not unusual, the Hutchings Station installation is typical of the cooperation of A-S-H Engineers with Utility Engineers in providing planned progress in ash handling—whether it be a new station or the expansion of existing facilities.

Your local A-S-H Sales Engineer will be glad to tell you more about this cooperative problem-solving, as typified by the Hutchings Story. Ask him. If you don't know your local representative, drop us a line and we'll arrange for him to get in touch with you.

*A-S-H service doesn't stop with installation. When service problems come up, we stand ready to give prompt service assistance. This is a policy worth considering when suppliers are being selected.*

**MATERIALS HANDLING SYSTEMS**

**"Hydrojet"** *hydraulic*

**"Hydrovac"** *pneumatic*

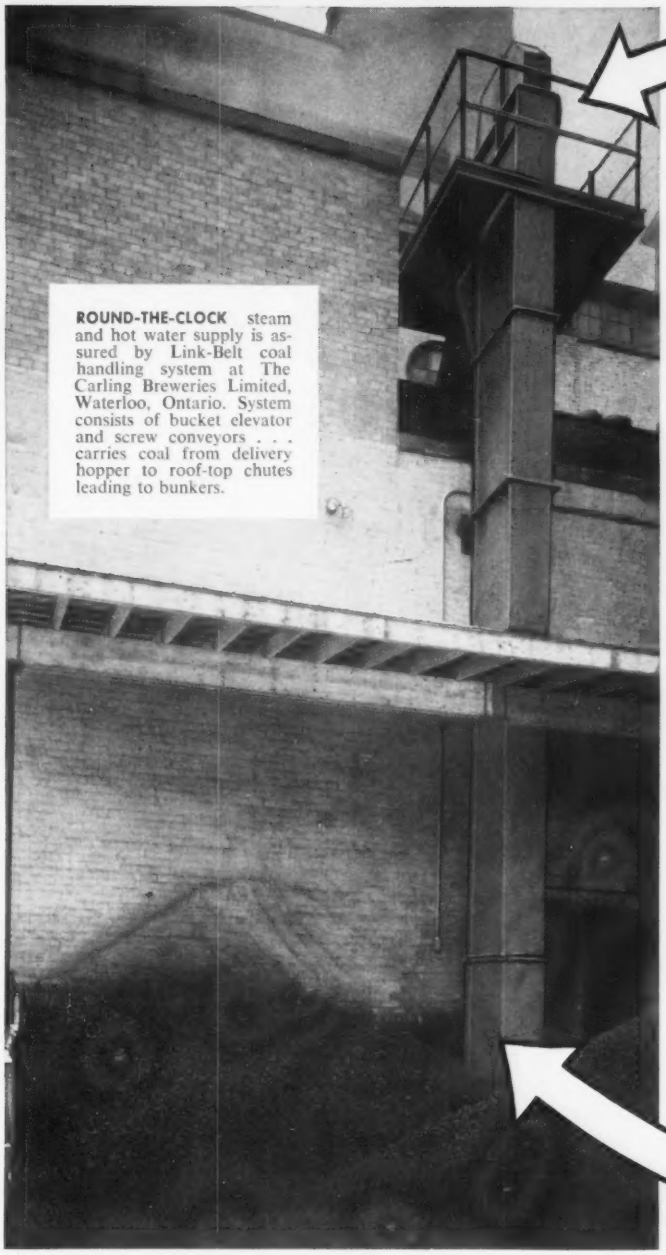
the **Allen-Sherman-Hoff** company

259 E. Lancaster Ave., Wynnewood, Pa.

*Offices and representatives in principal cities*

## Characteristic of efficient coal handling, this LINK-BELT system is

# simplicity itself



**ROUND-THE-CLOCK** steam and hot water supply is assured by Link-Belt coal handling system at The Carling Breweries Limited, Waterloo, Ontario. System consists of bucket elevator and screw conveyors . . . carries coal from delivery hopper to roof-top chutes leading to bunkers.

**LINK-BELT SCREW CONVEYORS** on roof of boiler house. Conveyor in foreground discharges to chutes which feed boiler bunkers.

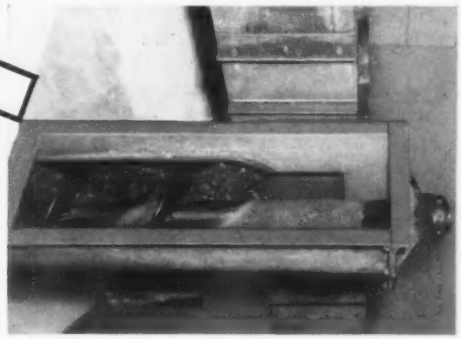
### Long engineering background and broad equipment line produce low cost handling

Coal handling at the Waterloo, Ontario plant of The Carling Breweries Limited is typical of Link-Belt's ability to custom-tailor systems to the special needs of any size plant, from large central power stations to small boiler houses.

Whether received by boat, rail or truck . . . inside or outside storage—Link-Belt engineers can bring a vast store of experience to focus on your particular problems. And this experience plus Link-Belt's complete line of equipment assures low-cost-per-ton answers.

If desired, Link-Belt will work with you and your consultants from planning through erection of your system. Call your nearest Link-Belt office. Send for Book 2410.

**LINK-BELT HELICOID SCREW FEEDER** transfers coal from truck hopper to boot of bucket elevator. Elevator moves coal to screw conveyors on roof.



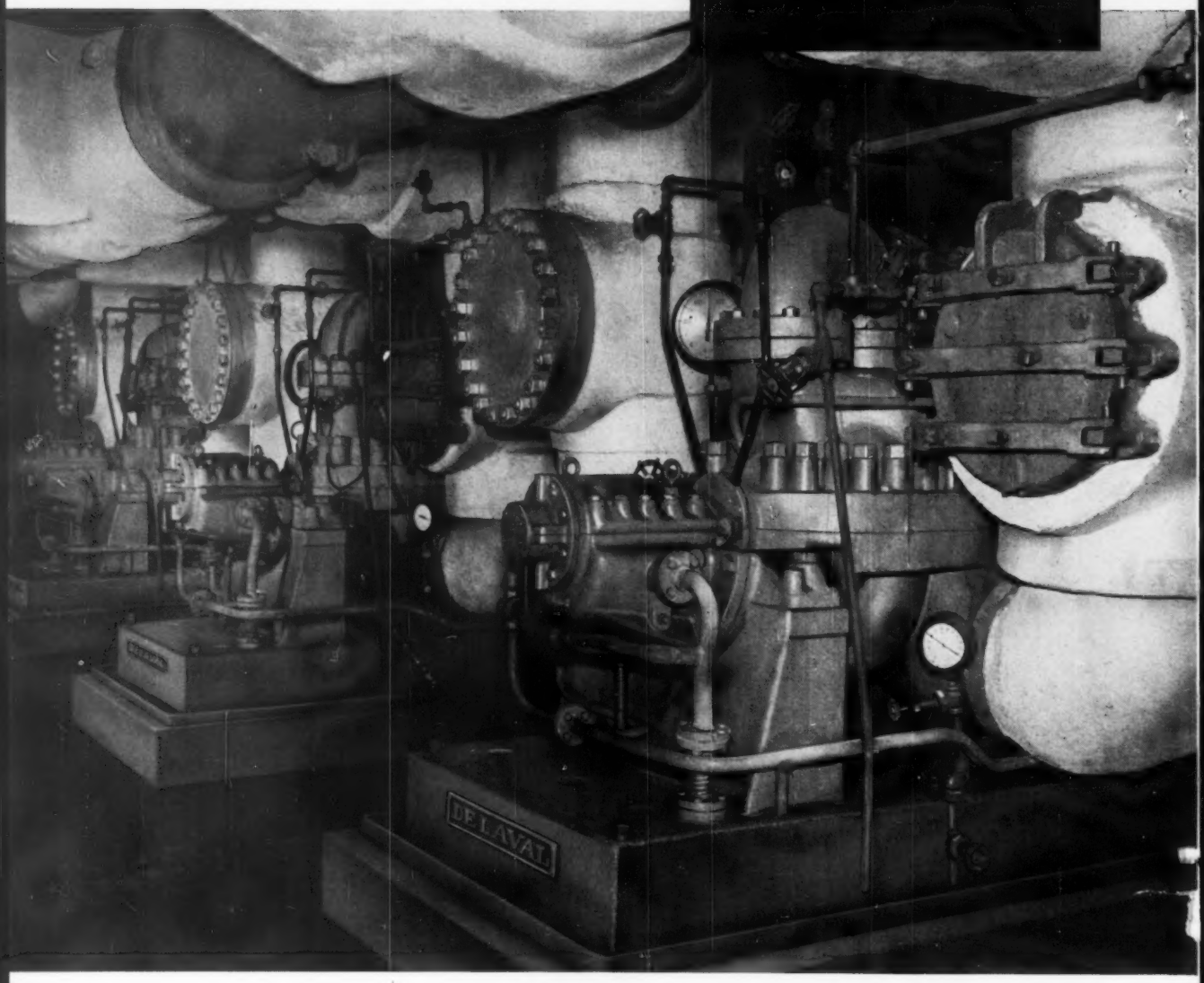
**LINK-BELT** COAL HANDLING EQUIPMENT

**LINK-BELT COMPANY:** Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants and Sales Offices in All Principal Cities. Export Office, New York 7; Australia, Marrickville (Sydney); Brazil, Sao Paulo; Canada, Scarboro (Toronto 13); South Africa, Springs. Representatives Throughout the World. 14,310

# *Con Edison reorders*

# DE LAVAL

## BOILER FEED PUMPS




The three De Laval Oppeller Pumps, shown in the photograph, do a dependable job of handling boiler feedwater at the East River Station of the Consolidated Edison Co. of New York. These three-stage pumps, with double-suction in the first stage, have a capacity of 2,000 gpm and operate at a discharge pressure of 620 psig. As proof of their reliable performance, Con Edison has ordered two identical units for the expansion of this station *plus* similar pumps for their Indian Point nuclear generating station.

Excellent for *medium* pressure and temperature service, De Laval Oppeller Pumps are designed with opposed impellers that balance axial thrust. Standard design features include sleeve bearings and labyrinth wearing rings which assure long economical service.

For *high* pressure, *high* temperature boiler feed service, De Laval offers the barrel-type pump . . . a single-suction, radially split diaphragm type multi-stage pumping unit inside a forged steel barrel.

**For more data on these dependable pumps, write for Catalogs 1502 and 1506**

**DE LAVAL** *Boiler Feed Pumps*

DE LAVAL STEAM TURBINE COMPANY

*815 Nottingham Way, Trenton 2, New Jersey*

DL 413

# In Power this month

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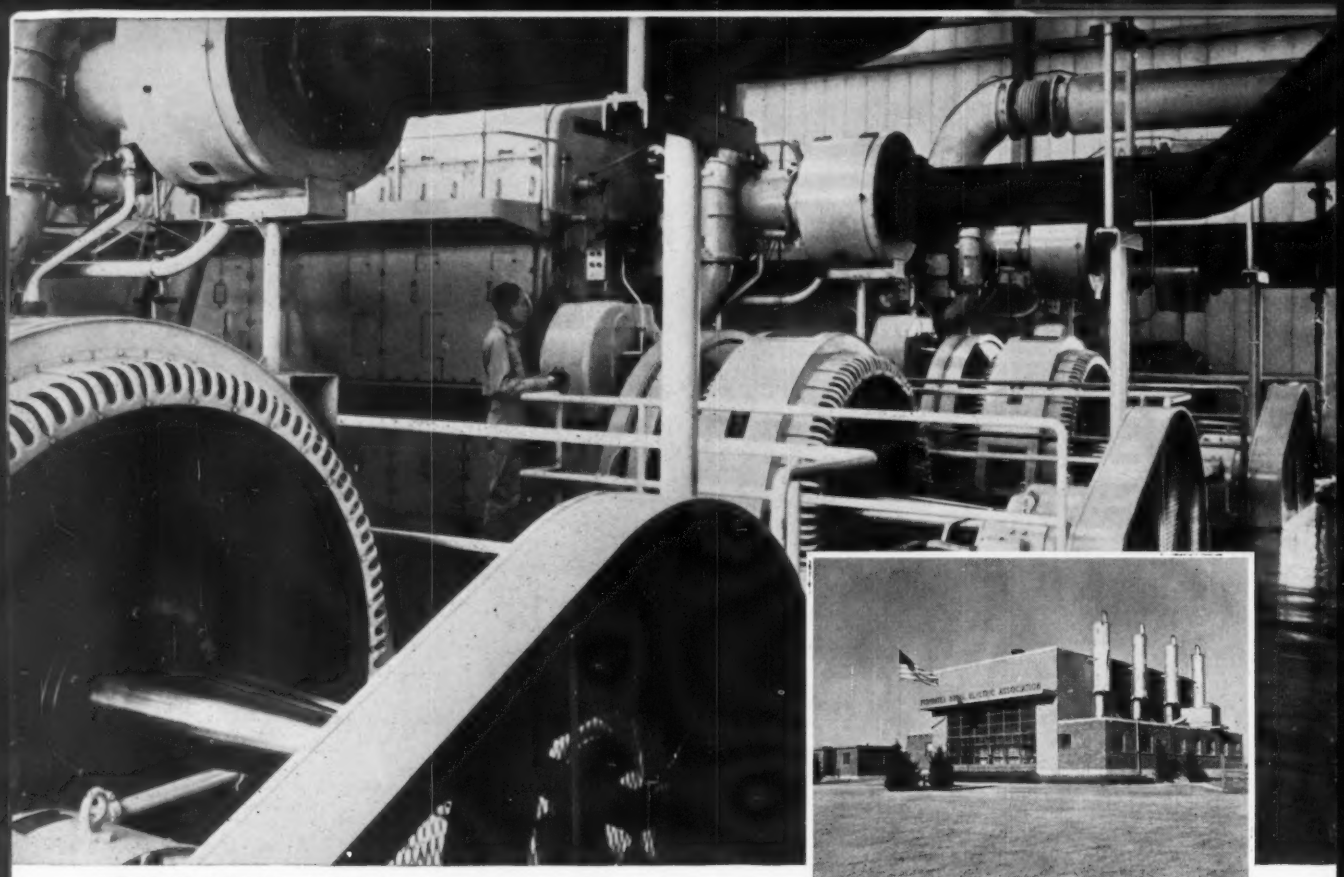


**EFFICIENCY AWARD** for 1957 (Division A) goes to Federated Rural Electric Assn. for producing power at the low cost of only 6.54 mills per kwh. Manager Paul L. Ferguson reports that "Lubrication with Texaco Ursa Oil Heavy Duty, and frequent thorough engine checks, have kept average liner wear (all engines, all cylinders) down to 0.005" after 33,000 hours' operation."



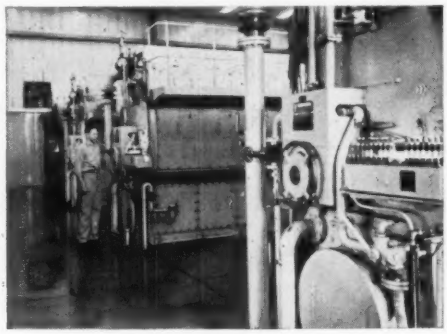
**A GOOD NEIGHBOR** as well as an efficient one, Federated's modern plant is handsomely landscaped, and the engines exhaust into Maxim silencers.

# "MOST EFFICIENT" REA PLANT WINS TITLE WITH TEXACO

A combination of rigid maintenance standards and the use of Texaco Ursa Oil Heavy Duty has won two *Diesel Progress* awards for efficiency for Federated Rural Electric Association, Jackson, Minn. In 1954, and again in 1957, Federated was named "the most efficiently operated of all REA internal combustion plants." This is how Texaco has helped Federated stay on top:

**Texaco Ursa Oil Heavy Duty keeps engines clean,** for maximum efficiency. It prevents formation of sludge, keeps the rings free and compression high, so the engine uses less fuel, and runs longer between scheduled overhauls.

**Minimizes wear,** too. Texaco Ursa Oil Heavy Duty is a premium quality lubricant—one of a complete line of Texaco Ursa Oils especially refined and processed to lubricate diesel, gas and dual-fuel engines. For details on what Texaco Ursa Oils can do in your plant, call the nearest of the more than 2,000 Texaco Distributing Plants in the 48 States, or write The Texas Company, 135 East 42nd Street, New York 17, N. Y.



**POWERFUL PERFORMERS** stay powerful with Texaco Lubrication. Each 8-cylinder 4-cycle Nordberg Dua-fuel engine is rated at 1750 hp at 327 rpm.

LUBRICATION IS A MAJOR FACTOR IN COST CONTROL

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# speaking of Power

**TOP HONORS** came again to Power editors last month when the much-awaited results of the Annual Industrial Marketing Editorial Achievement Competition were announced. Our peers selected *Energy*, the eye-catching 48-page special report that appeared in our 75th Anniversary Issue, as the "Best Single Article" to be published in an industrial publication during the year 1957.

Although each staffer is soaking in some reflected glory, and rightly so, the planner and doer of this most significant report was Associate Editor Ben Skrotzki. Overall presentation design came off the drawing board of consultant Ladislav Sutnar. While Skrotzki has racked up many honors during his 13 years as a Power editor, his latest, I am sure, will be held in extra high regard. An illustrated trip through the world of energy—past, present and future—is one few would tackle as engineering guide.

Lou Lowley


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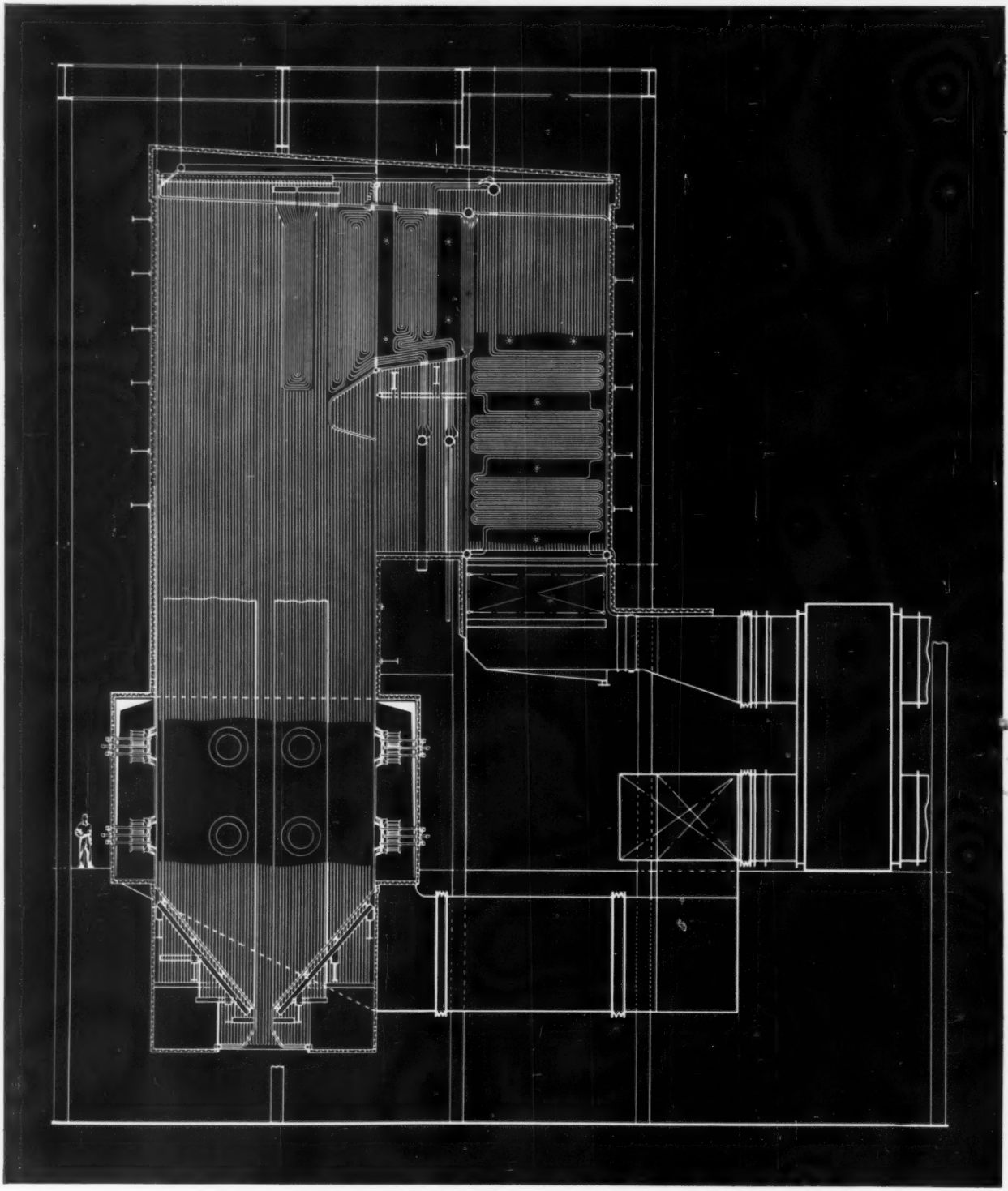
# A Big Step Forward-



Newest UP unit for Southern California Edison will provide steam at a rate of 1,638,000 lb per hour to a 210,000 kw turbine at a pressure of 2,400 psi and at a temperature of 1,050/1,000 F. Completion of the unit, which will burn either natural gas or oil, is scheduled for November, 1960.

# Why Southern California Edison Purchased B&W Universal Pressure Boiler for 2400 PSI Operation

## Once-Through Unit Reduces Capital and Operating Costs —Makes Use of Variable Pressure Possible

A big forward step in holding the line on the cost of producing electricity was taken by Southern California Edison in purchasing two B&W Universal Pressure units for its station at Huntington Beach, California.

Solid savings both in installed first cost and in operation stand behind this decision. Here are the facts:

### INSTALLED COST

1. The overall cost of a Universal Pressure Boiler represents a saving over a drum type boiler for identical conditions.
2. Because height and weight of the UP Boiler are much less than those of drum type boilers, there are worthwhile savings in building and construction costs.
3. Superheat, hot reheat and cold reheat steam piping are reduced.
4. Foundation costs reduced because of 650 ton saving in weight of unit.
5. Drum transporting and lifting costs eliminated.
6. One level of stairs, walkways and elevator landing eliminated.

### OPERATION

Many significant advantages from the UP's unique operating features helped shape Southern California Edison's decision. Here is what they found:

1. Constant steam temperature at all loads without use of tempering equipment.
2. Rapid response to load change.
3. Quick start up and shut down.
4. Simplified control system during normal operation.
5. Minimized operating complications when turbine is tripped.
6. Complete flushing of preboiler and boiler system is accomplished during every start up and shut down.
7. Reduced dependence on safety valves.
8. Elimination of water level gauge glasses and indicators.
9. Ease of acid cleaning.

### VARIABLE PRESSURE OPERATION

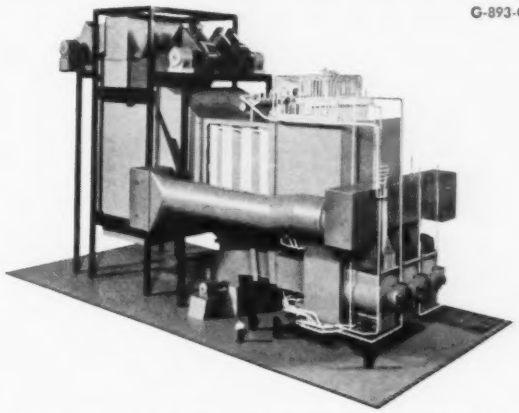
The Universal Pressure Boiler can be operated with variable pressures and constant steam temperature over a wide load range. This not only means more efficient operation at partial loads, but also cuts auxiliary power requirements at lower loads.

The Universal Pressure Boiler helps the utilities' pressing need to hold the line on most of the important factors affecting cost of power generation.

Behind its many benefits stands the concrete performance of America's first successful commercial application of the Universal Pressure principle at the Philo Plant of the Ohio Power Company on the American Electric Power System. This unit has had a full year of performance under diversified conditions. Performance, ease of operation and freedom from major troubles have exceeded even the optimum original expectations.

We would be glad to discuss with you the advantages that the Universal Pressure Boiler can bring to your plant. Write to The Babcock & Wilcox Company, Boiler Division, 161 East 42nd Street, New York 17, N. Y.

G-893-CS

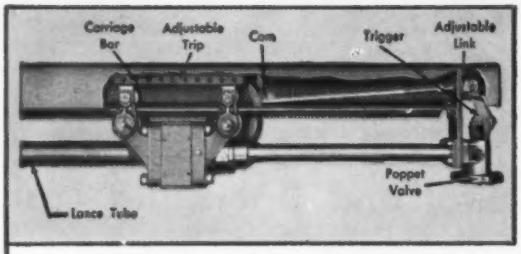


Model of the first Universal Pressure Boiler, which is now operating, uses once-through principle by which water, under pressure, is forced in one end of the system and emerges at the other end as superheated steam. This principle eliminates need for a drum.

BABCOCK & WILCOX

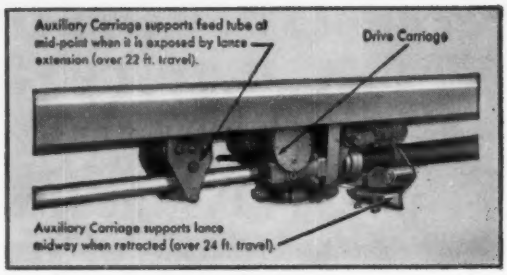
BOILER DIVISION

# *Reasons* FOR THE ENTHUSIASTIC ACCEPTANCE



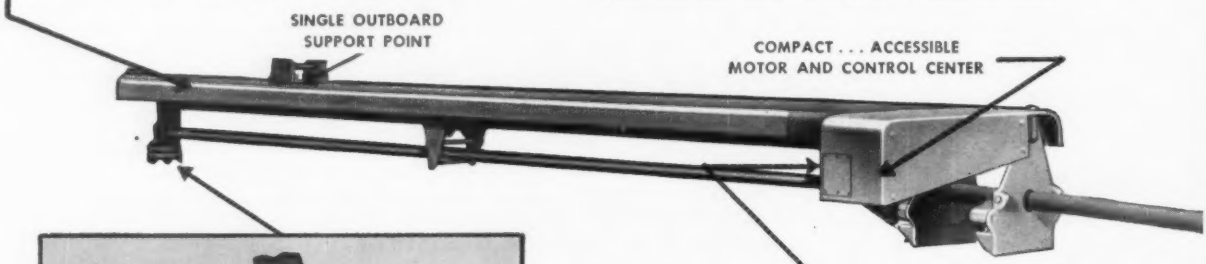

### MECHANICALLY OPERATED VALVE

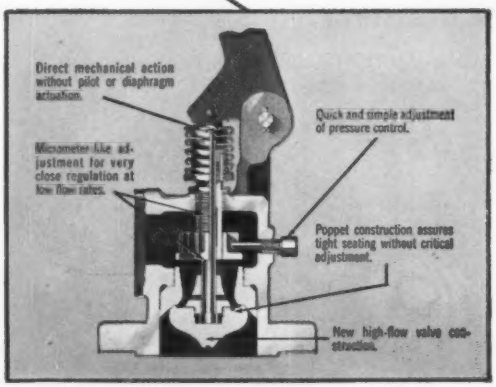
Control of blowing medium is automatic, positive and accurate by means of a simple, dependable mechanically operated valve. As lance begins movement into boiler, trip on carriage opens valve through a linkage. At end of retraction, trip closes valve. All pilot or diaphragm valve elements are eliminated. Trip is adjustable.


Auxiliary Carriage supports feed tube at mid-point when it is exposed by lance extension (over 22 ft. travel).
Drive Carriage
Auxiliary Carriage supports lance midway when retracted (over 24 ft. travel).

### AUXILIARY CARRIAGES (FOR EXTRA LONG TRAVEL)

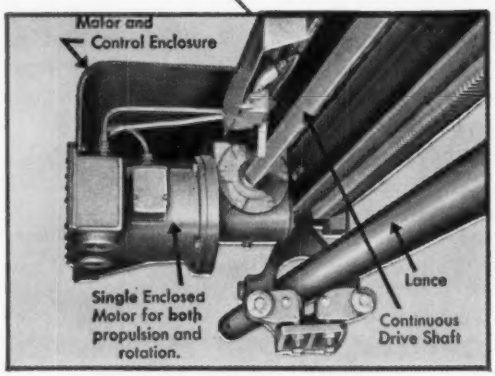
On extra long blowers, one auxiliary carriage supports lance midway when retracted, preventing undue bending. Second auxiliary carriage is dropped at mid-point to support feed tube when it is exposed by lance extension.





Direct mechanical action without pilot or diaphragm actuation.
Micrometer like adjustment for very close regulation at low flow rates.
Quick and simple adjustment of pressure control.
Poppet construction assures tight seating without critical adjustment.
New high-flow valve construction.

### POPPET VALVE WITH ADJUSTABLE PRESSURE CONTROL

Diamond dependable poppet valve with improved streamlined flow contours and adjustable pressure control that permits easy, accurate setting of pressure at individual valve and independent of other blowers. Poppet construction assures tight seating without critical adjustment. Stem, seat and disc are stainless steel. Stellited seating surfaces are available.




### STATIONARY GEAR MOTOR

Lance propulsion and rotation are by a *single* enclosed gear motor which drives a continuous shaft running the full length of blower and providing power to carriage. This construction makes it possible to mount motor in a fixed position at the front end for better protection and accessibility.

8077

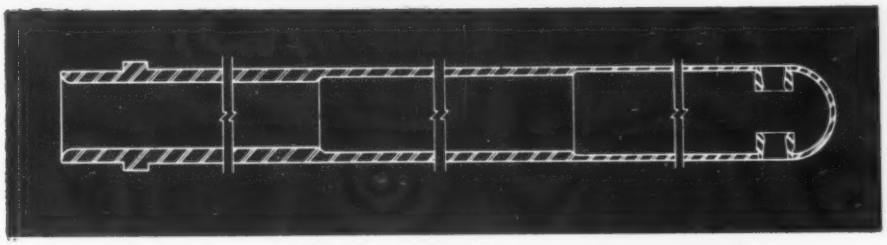
Diamond

**DIAMOND POWER**

# of the DIAMOND SERIES 300 IK
# LONG RETRACTING BLOWER

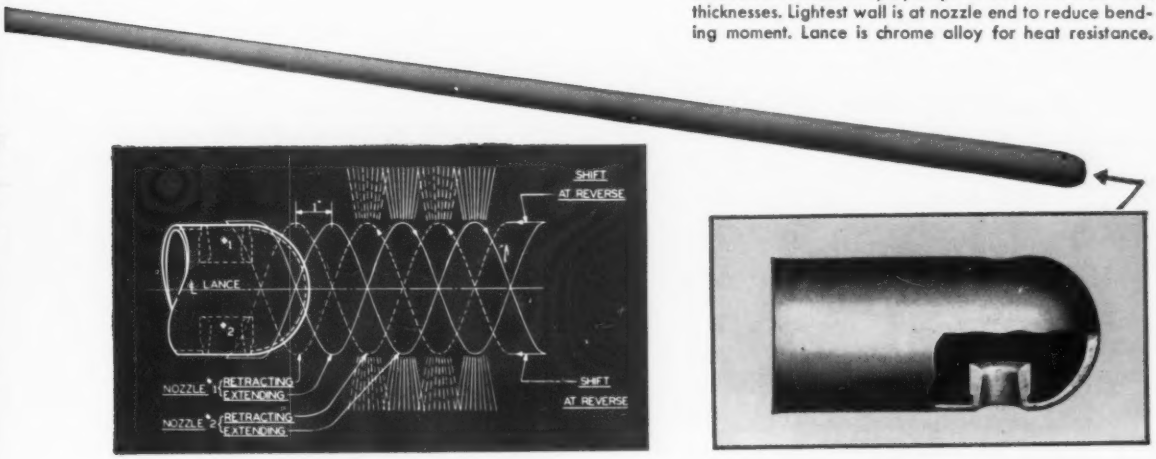
**The Diamond Series 300 IK Blower sets a new and higher standard of efficiency, economy and dependability in the cleaning of heating surfaces that require a long retracting lance type blower. Pointed out in detail are some of its important features. Others are a *single* outboard support point to simplify installation and the attractive "backbone" cover for greater rigidity and protection of the entire blower assembly from dirt, damage, the elements and personnel hazards.**

**This new Series 300 IK is the culmination of more than 20 years' experience building and applying long travel blowers. It well illustrates the Diamond design philosophy: *"Keep it simple . . . keep it basic . . . avoid unnecessary complications."* It is further evidence of the fact that YOU CLEAN BOILERS BETTER AND AT LOWER COST WITH DIAMOND BLOWERS.**



**STEP-TAPER LANCE**
**(FOR EXTRA LONG TRAVEL)**

Extra long lance has minimum droop due to step-taper construction which employs up to four different wall thicknesses. Lightest wall is at nozzle end to reduce bending moment. Lance is chrome alloy for heat resistance.




**IMPROVE CLEANING PATTERN**

Close and positively controlled helical cleaning pattern assures maximum cleaning effectiveness. Blowing pattern diagram illustrates how return travel path is exactly intermediate with forward travel path so that there is a *positive nozzle sweep every inch.*

**IMPROVED DIAMOND NOZZLE**

New design Diamond "Type A" Nozzle is the result of several years' research and the testing of more than 50 different contours. The modified venturi produces maximum impact pressure and cleaning effectiveness with minimum expenditure of cleaning medium. (Steam or compressed air.)

*For further information, ask the nearest Diamond office or write directly to Lancaster for Bulletin 2111U.*

**SPECIALTY CORP.** **LANCASTER, OHIO**
DIAMOND SPECIALTY LIMITED—Windsor, Ontario

# LARGEST SINGLE-FURNACE STEAM GENERATOR

# WILL DELIVER 2,310,

# for Unit No. 4 at Union

## *New 300,000 kw generating unit will increase station capacity to 860,000 kw*

WITH Unit No. 3 still in the final stages of construction, Union Electric Company has already contracted for the addition of Unit No. 4 to the fast-growing Meramec Station. This new generating unit, scheduled for completion in 1961, will be the largest on the Union Electric system, adding 300,000 kw and bringing Meramec Station's total capacity to 860,000 kw.

Steam for the new turbo-generator will be supplied by a Foster Wheeler reheat steam generator with a maximum continuous rating of 2,310,000 pounds per hour — the largest FW single-furnace unit ever built! Pressure at the superheater outlet will be 2200 psig and primary and reheat steam will have a final total temperature of 1010F/1010F, with a reheat steam flow of 1,790,000 lb/hr.

The unit is designed for balanced draft operation, firing pulverized coal. Three Foster Wheeler D-9 Ball Mill Pulverizers will prepare fuel for the 18 FW Intervane Burners.

The new 2,310,000 lb/hr steam generator will take its place beside another FW unit — the 1,850,000 lb/hr twin furnace, dual circulation reheat steam generator for 275,000 kw Unit No. 3 at Meramec Station.

The proved dependability and long-range economy of Foster Wheeler steam generators are backed by more than 50 years of experience in pioneering power plant equipment. We will be pleased to quote on your requirements.

*Foster Wheeler Corporation, 666 Fifth Avenue, New York 19, N. Y.*

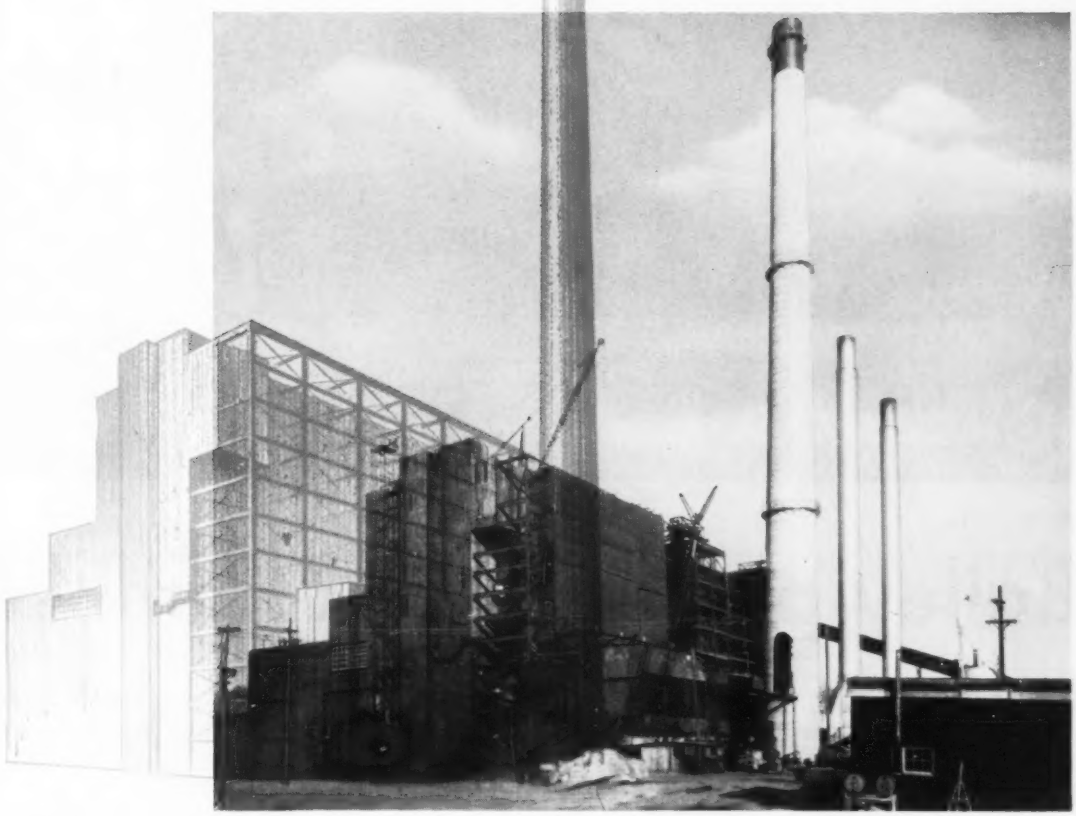
STEAM GENERATORS • SURFACE CONDENSERS
FEEDWATER HEATERS • HEAT EXCHANGERS • ECONOMIZERS
SUPERHEATERS • BALL PULVERIZERS • COOLING TOWERS

FOSTER

## EVER BUILT BY FOSTER WHEELER

# 000 lb/hr

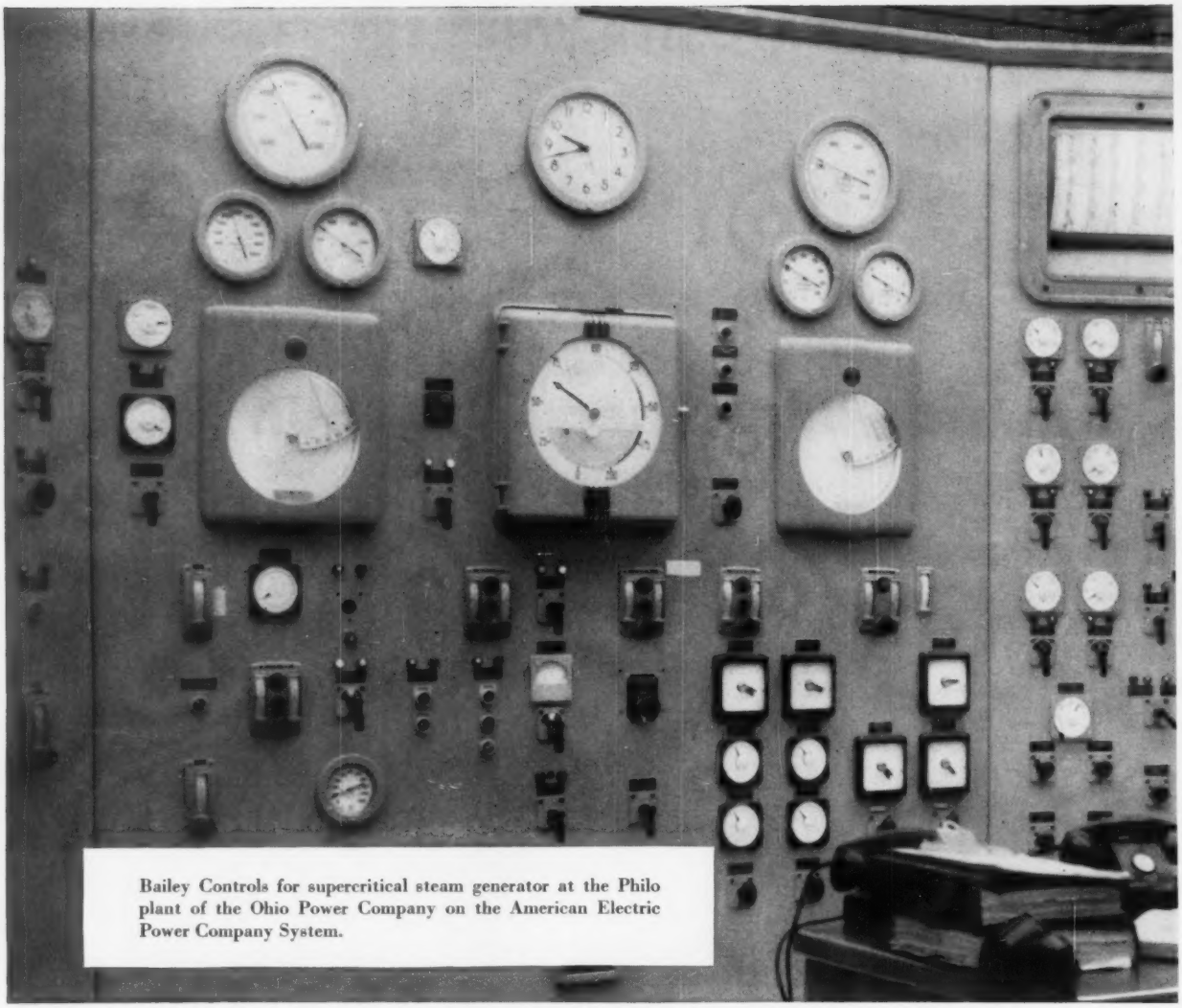
## Electric's Meramec Station



The photo above shows Union Electric's Meramec Station, with Unit No. 3 under construction. This 275,000 kw unit, supplied by a Foster Wheeler twin furnace, dual circulation reheat steam generator of 1,850,000 lb/hr capacity, is scheduled to go on the line this summer. The artist's sketch, in color, shows the location of 300,000 kw Unit No. 4, which, when completed in 1961, will bring total station capacity to 860,000 kw. The new unit will be served by the largest single-furnace steam generator ever built by Foster Wheeler — with a maximum continuous rating of 2,310,000 lb/hr, 2200 psig, 1010F/1010F.

WHEELER

NEW YORK • LONDON • PARIS
ST. CATHARINES, ONT.



Bailey Controls for supercritical steam generator at the Philo plant of the Ohio Power Company on the American Electric Power Company System.

# Bailey pioneers the control of...

*This is the control center* for the first commercial supercritical pressure, steam-electric unit in America. It went into operation March 20, 1957. Tests made during the first year of operation indicate that this new high pressure unit, with Bailey Controls, is establishing new efficiency records in the conversion of coal to electricity.

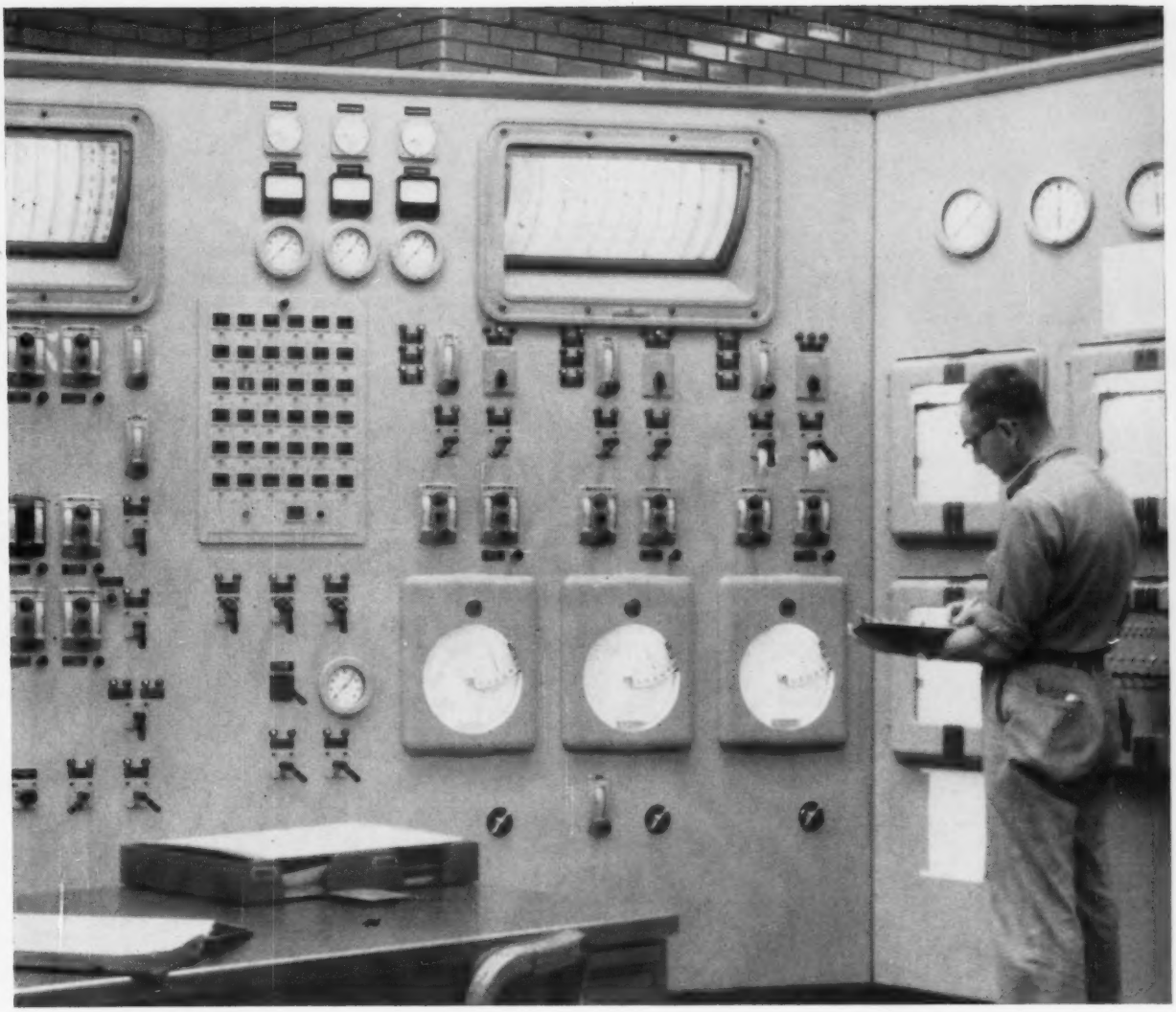
## How it works

*"Once-through" steam generating units* must have radically different control systems from those used on drum-type boilers. At Philo, for instance, the Bailey Control for the 4500 psi, 1150F unit, maintains the desired rate of steam generation by means of a feed water flow controller which regulates feed-pump speed.

*In normal operation* this controller is set for a constant rate, and boiler outlet pressure is held to the desired value by automatic regulation of the turbine control valves.

*An alternative operating method* uses the turbine speed governor to regulate turbine control valves and varies feed water flow to maintain boiler outlet pressure.

*With either method* firing rate is varied to maintain final steam temperature. The Bailey System does this by regulating coal and air in parallel, primarily from changes in feed water flow with secondary adjustments, when necessary, from steam temperature.



# SUPERCRITICAL STEAM PLANTS

*Optimum combustion conditions* are maintained by Bailey Oxygen-Combustibles Recorder-Controllers which continuously sample exit gases from each cyclone and automatically adjust coal feeder speeds.

**Seasoned Engineering Experience**

For greater fuel savings, less outage and safer working conditions, you owe it to yourself to investigate Bailey Controls. And, for your convenience (and to save time and travel expense) there's a Bailey District Office or Resident Engineer in or close to your industrial community.

Arrange to visit a nearby Bailey installation. We stand on our record. A135-2

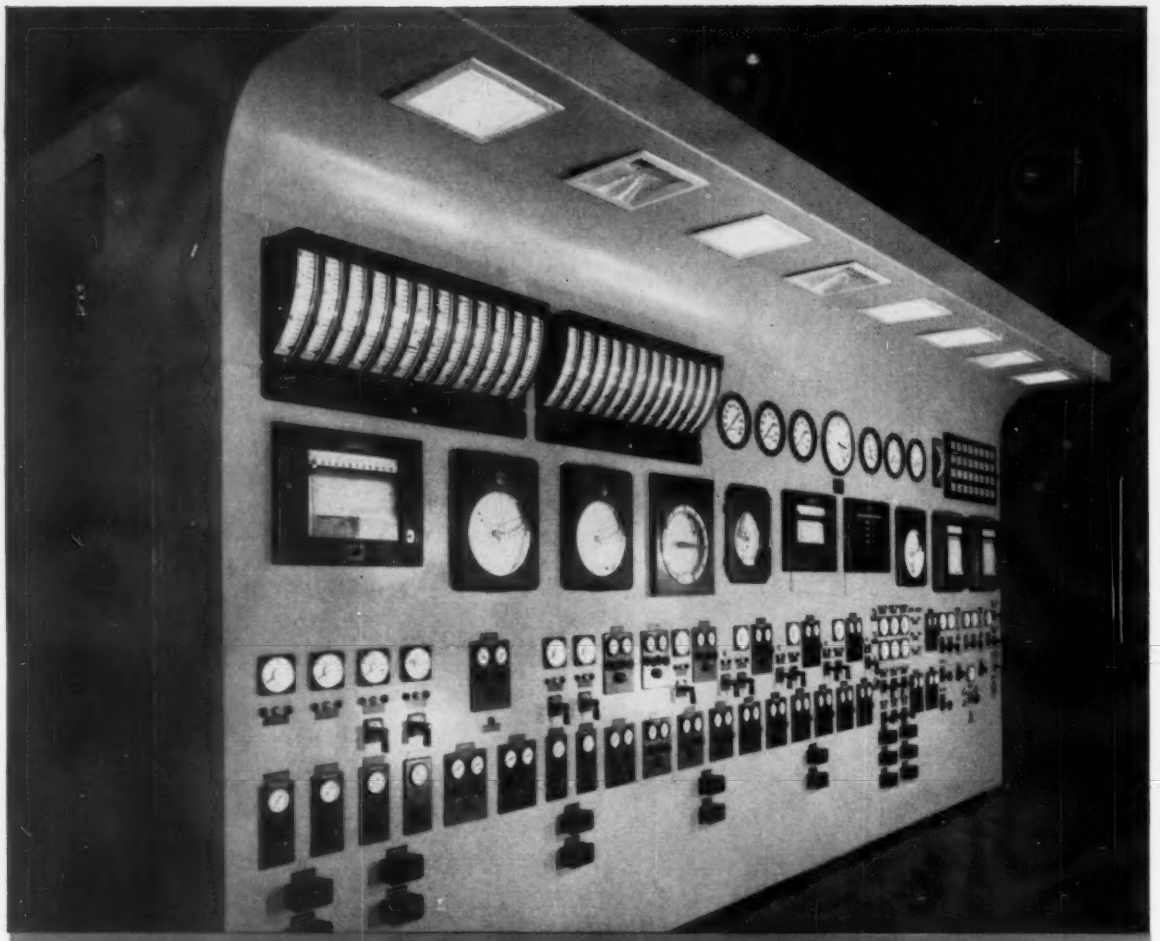
***Instruments and controls for power and process***

## BAILEY METER COMPANY

*1036 IVANHOE ROAD • CLEVELAND 10, OHIO*

In Canada—Bailey Meter Company Limited, Montreal

BAILEY METERS



**Boiler Operating Panel.** Built by Copes-Vulcan, this panel provides all necessary processing information. It permits firing the furnace or feeding water to the boiler automatically or by remote manual control. Identical Trapset controllers and relays simplify maintenance procedures and minimize spare parts stocks.

# Copes-Vulcan Boiler Control installed at Seward Station

Pennsylvania Electric Company's Seward Station uses an integrated Copes-Vulcan system to provide efficient boiler control. Built to maintain a constant main steam-header pressure under all load conditions, this modern control system provides simplicity of circuits and dependable accuracy of components.

**Correcting pressure changes automatically.** Fuel feed responds to deviations in steam pressure resulting from changes in steam flow rate, and generates the exact amount of steam to restore header pressure. The system also maintains constant drum level.

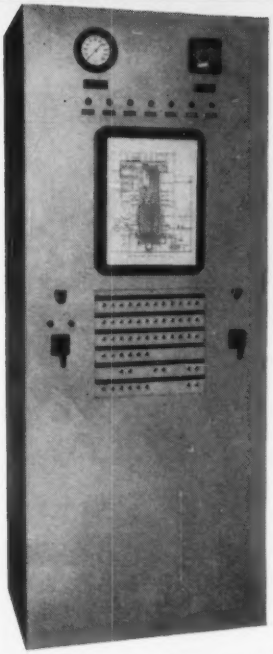
Mill temperature control, mill-totalizing circuit and boiler feed pump recirculation control are additional functions of this efficient control system.

**Bumpless transfer simplifies operation.** All Copes-Vulcan auto-manual stations provide a continuous picture of performance, permit automatic-to-manual selection without the complications of seal balance.

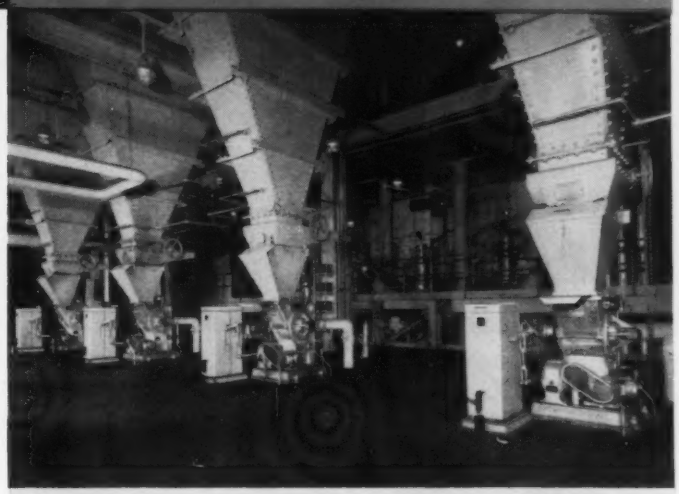
Noted for modern design, high speed response and precision performance, Copes-Vulcan boiler control systems and Vulcan soot blowing systems cut operating costs at modern stations everywhere.

Whether your boiler is large or small, power or process, your Copes-Vulcan representative has the ideas, information and experience to help you choose the system to best meet your needs.

# C-V NEWS NOTES

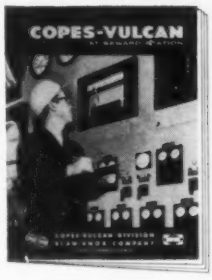


**Seward's soot blower system.** A Vulcan automatic-sequential control system keeps soot blowers operating in proper sequence. Panel switches permit any soot blower to be cut out of the sequence or reblown if necessary.

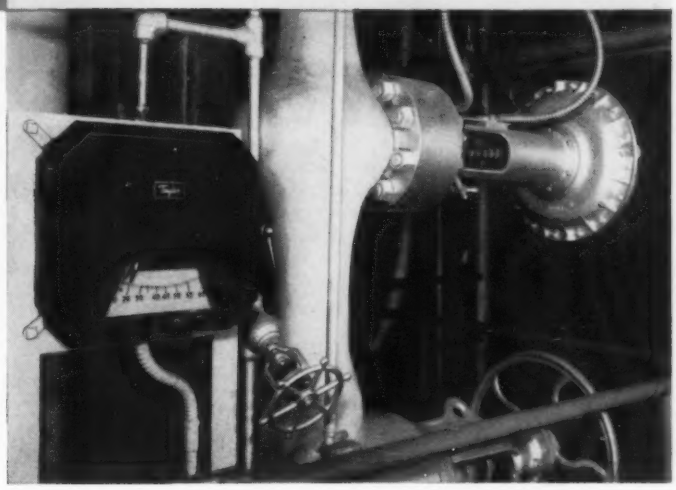


**Fuel feed drive units.** The units shown are typical of all drive units in the control system. A positioner, a four way valve, a power piston and feed-back cam are incorporated into each compact unit.

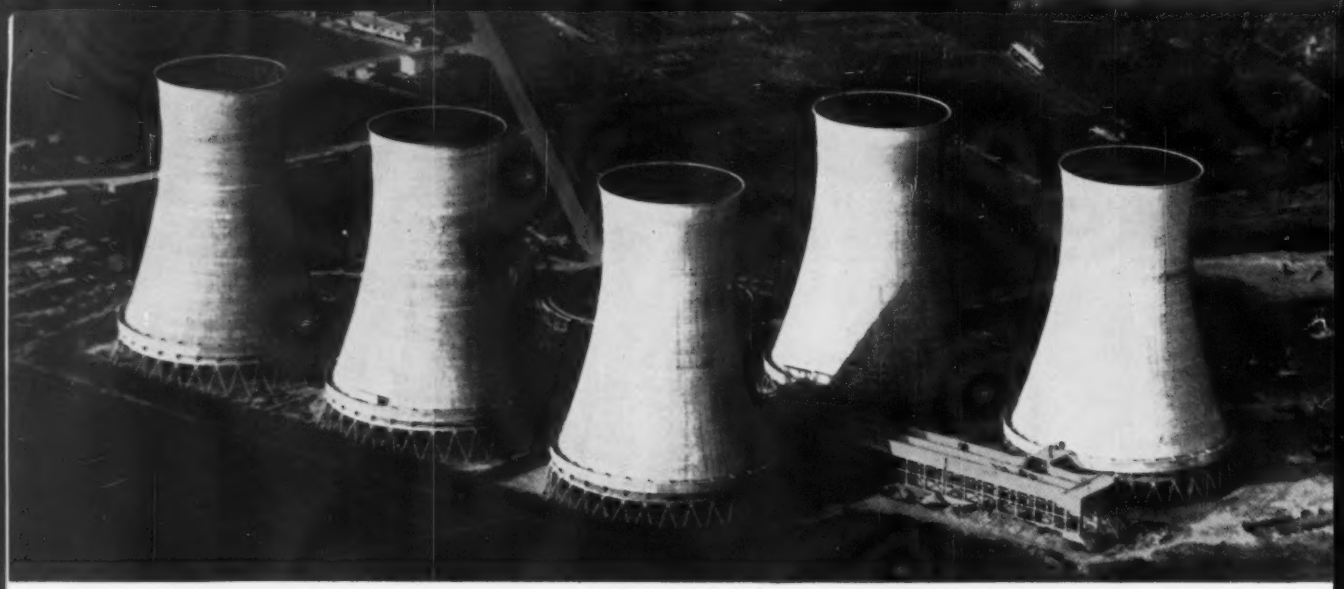
**Pump recirculation control.** When discharge from any pump falls below an established limit, an electric-contact low-flow control circuit opens a diaphragm operated by-pass valve to assure sufficient flow to prevent the pump from overheating.




**Write for Bulletin 1038.** This 12-page bulletin describes in detail Seward's complete control system. Schematic drawings show air-flow and fuel-loading loops. Boiler drawings locate Vulcan soot blowers and wall deslaggers.



COPES-VULCAN DIVISION
BLAW-KNOX COMPANY
ERIE 4, PENNSYLVANIA



*Introducing to American Industry...*

MARLEY MOUCHEL

# HYPERBOLIC NATURAL

The Marley Company, in association with L. G. Mouchel & Partners, engineers, London, presents to American industry the reinforced concrete HYPERBOLIC NATURAL DRAFT COOLING TOWER — a different concept in large-volume water cooling. New to this continent, Mouchel has a record of 35 years of successful service in over 500 installations in many countries. The universal success of these installations has firmly established the Mouchel organization as the world's outstanding designers.

These towers bring to the power industry established standards of durability and low operational expense that qualify them as most important in the economic pattern of 100-megawatt and larger plants that are now in the plan stage for tomorrow's power demands. These outstanding advantages are distinctive to the Marley-Mouchel cooling tower:

*The plant designer has complete freedom in location of the tower to conserve plant area and piping.* Hyperbolic Natural Draft Towers may be placed near the machines they serve since ground fogging and recirculation of warm, moist vapor do not occur.

*No fans—no horsepower is required.* Thermal power created by heating and humidifying the air is the only energy used. A valuable part of the plant's production is thus conserved for salable transmission.

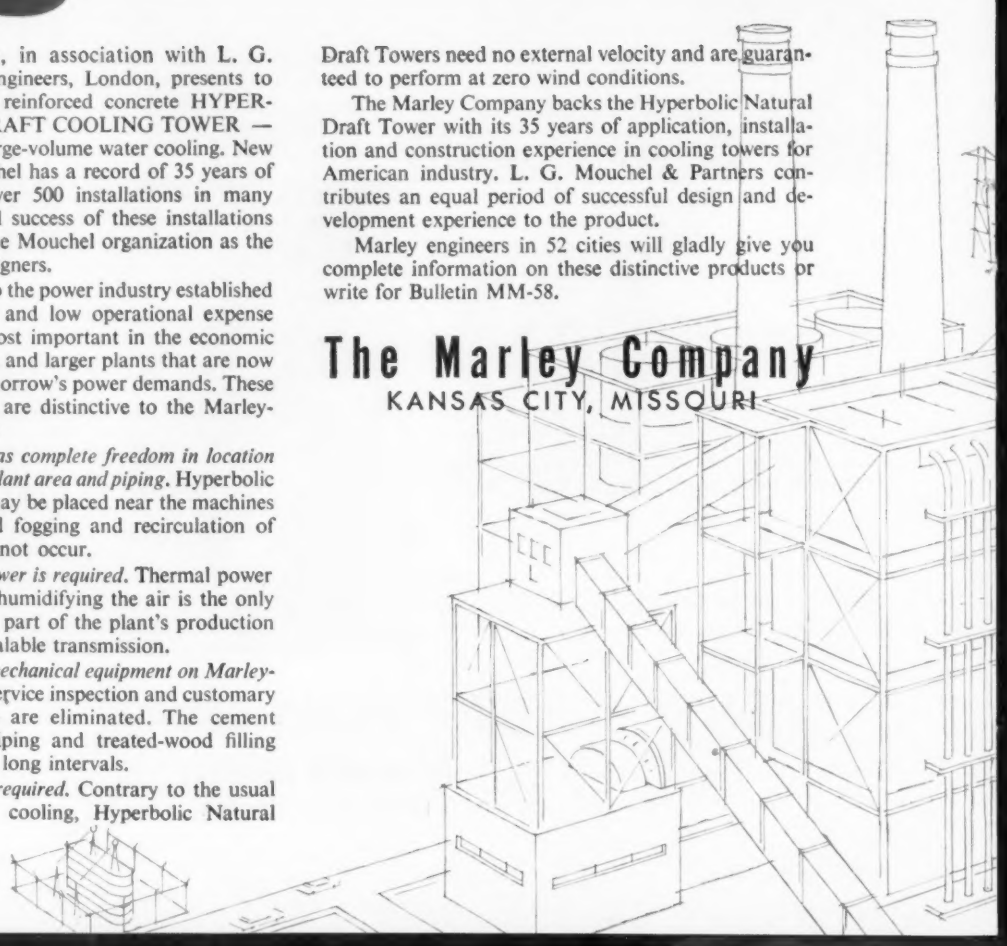
*There is no moving mechanical equipment on Marley-Mouchel towers.* Daily service inspection and customary maintenance schedules are eliminated. The cement asbestos distribution piping and treated-wood filling need inspection only at long intervals.

*No wind velocity is required.* Contrary to the usual theory of atmospheric cooling, Hyperbolic Natural Draft Towers need no external velocity and are guaranteed to perform at zero wind conditions.

The Marley Company backs the Hyperbolic Natural Draft Tower with its 35 years of application, installation and construction experience in cooling towers for American industry. L. G. Mouchel & Partners contributes an equal period of successful design and development experience to the product.

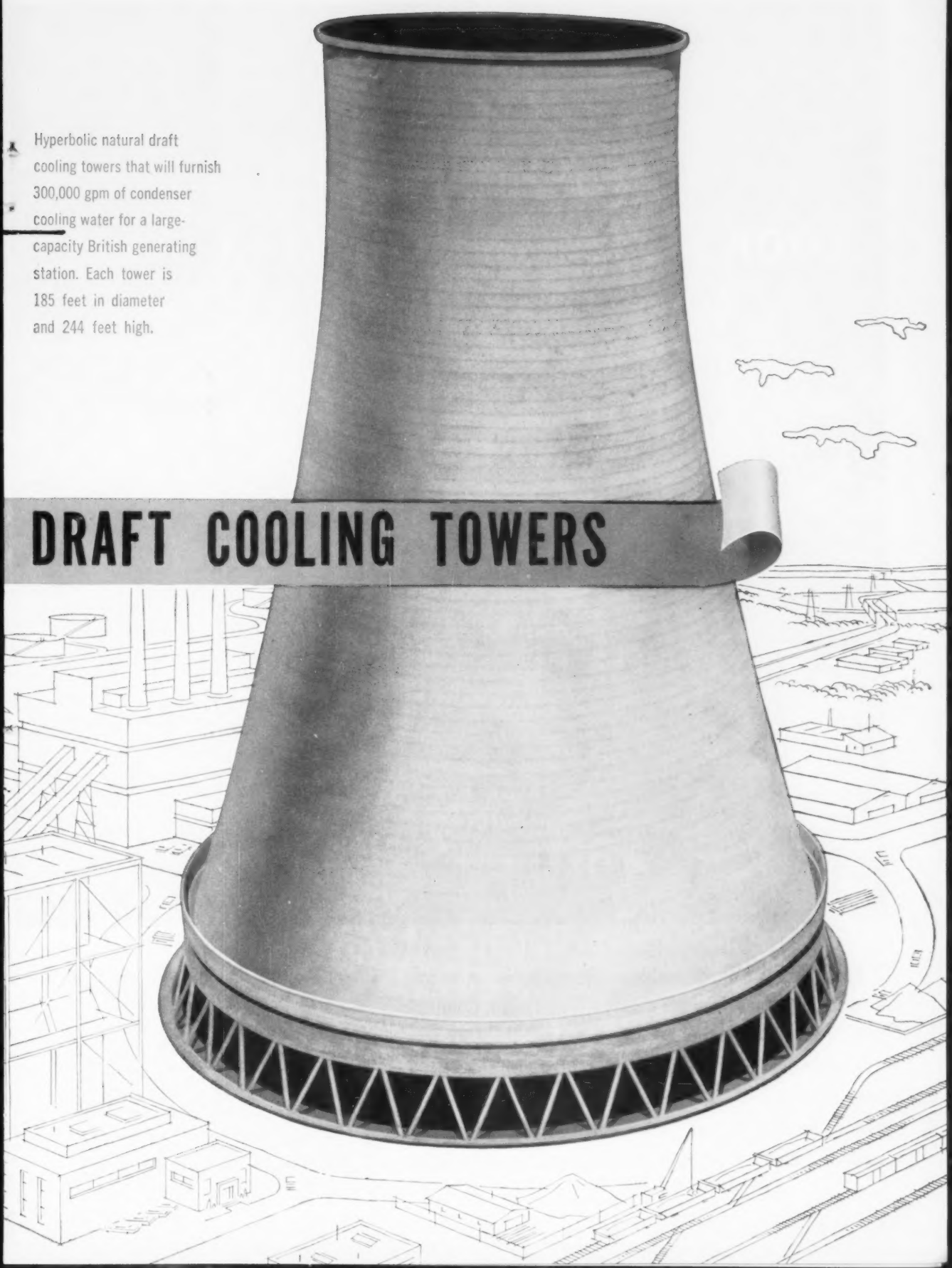
Marley engineers in 52 cities will gladly give you complete information on these distinctive products or write for Bulletin MM-58.

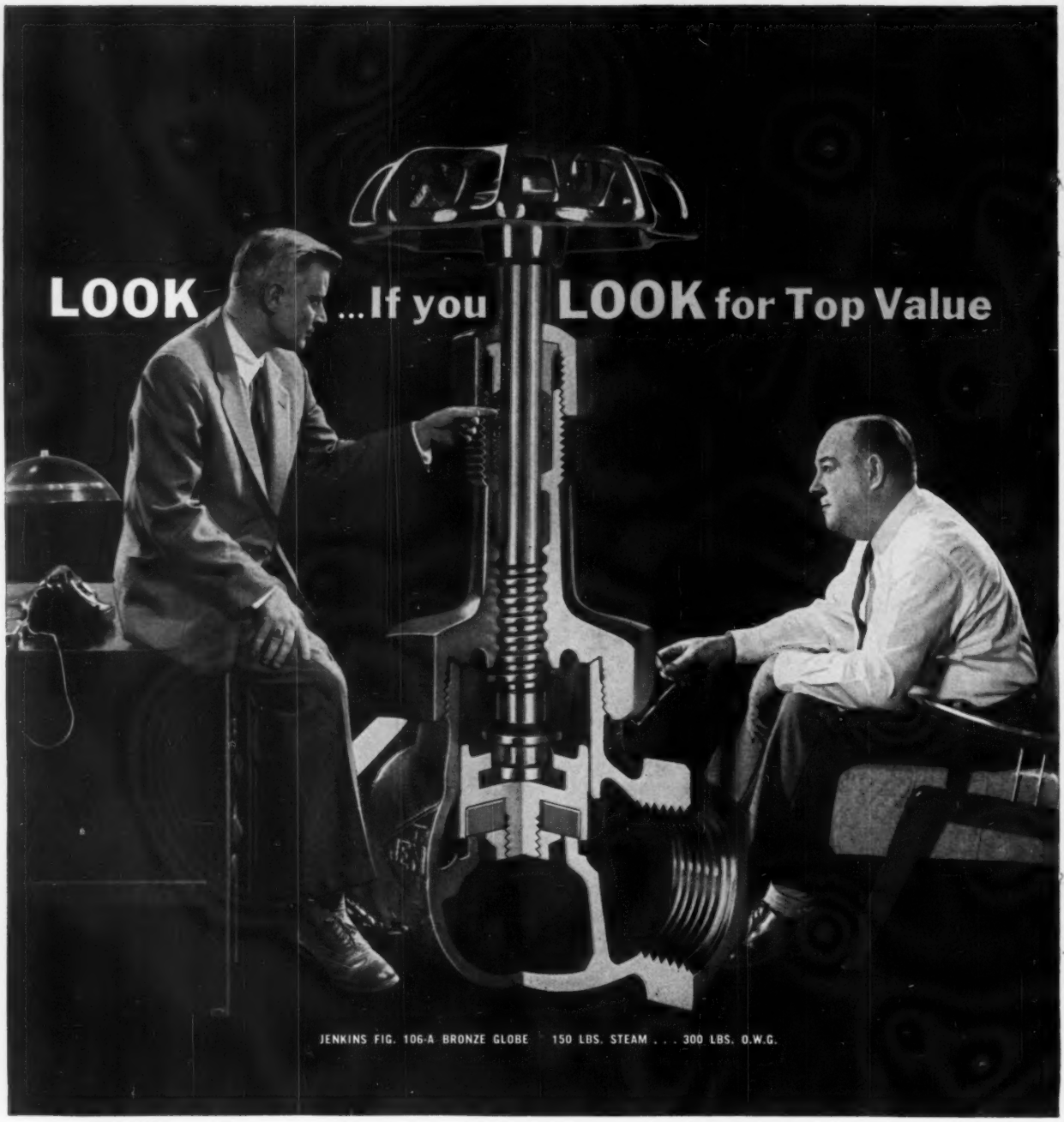
**The Marley Company**
KANSAS CITY, MISSOURI



# DRAFT COOLING TOWERS

Hyperbolic natural draft cooling towers that will furnish 300,000 gpm of condenser cooling water for a large-capacity British generating station. Each tower is 185 feet in diameter and 244 feet high.






**THE FIRST** renewable composition disc valve was a Jenkins Valve, originated nearly a century ago. Compare today's Fig. 106-A Bronze Globe with any other. See why so many valve users agree that a *Jenkins* is still the FIRST for top value. For descriptive folder No. 189-B on the full line of Jenkins Bronze Globe, Angle and Check Valves write to Jenkins Bros., 100 Park Avenue, New York 17.

JENKINS
LOOK FOR THE JENKINS DIAMOND
VALVES
JENKINS SINCE 1864 Jenkins Bros

*Sold Through Leading Distributors Everywhere*

## in DISC EQUIPPED BRONZE VALVES

**LOOK at that Wheel** — Tough malleable iron. Design unequalled for cool, sure grip.

**LOOK at the Index Plate** — Has Fig. No. etched in green background. Held by wheel nut.

**LOOK at the Wheel Nut** — Secured by rolled-over spindle end. A quality detail.

**LOOK at that Spindle** — Made of high tensile bronze. See how much heavier it is . . . how many more deeply cut threads engage bonnet. And, the crowned head that reduces friction on disc holder. Sure, it costs more to make a spindle this way. But it reduces wear, preserves packing, means easier operation.

**LOOK at the Packing Nut and Gland** — Note the heavy and deep bronze hex. And, that bronze gland designed to compress packing toward spindle.

**LOOK at that Packing Box** — Its depth equals 1½ times spindle diameter. More packing space means less repacking. An asbestos, lubricated and graphited packing is used.

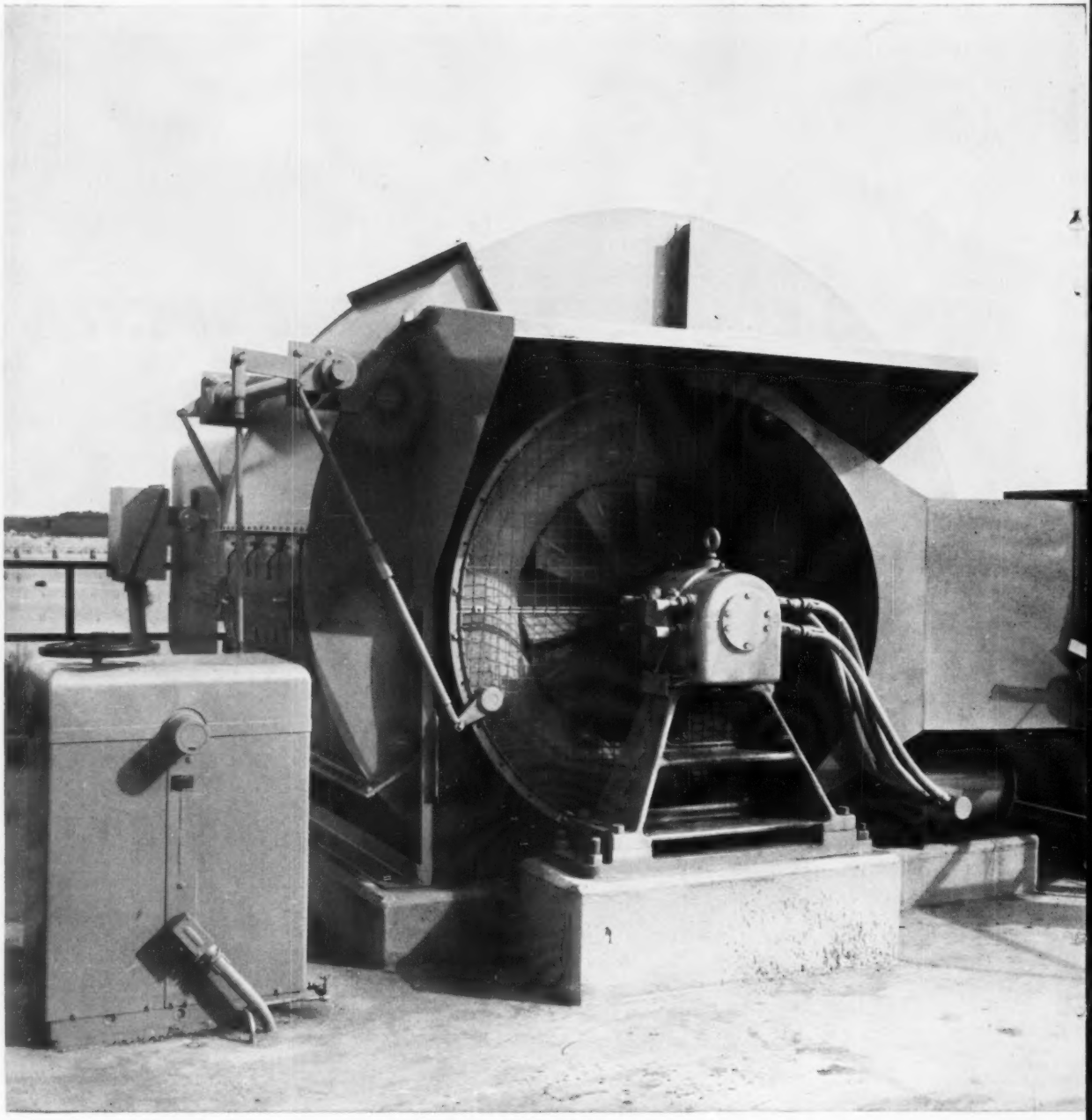
**LOOK at that Bonnet** — One-piece, screw-over design with big hex surfaces is easy to remove. Take an extra look at the bevel joint between bonnet and body, serving as an internal brace against the crushing effect of the bonnet assembly. Millions of Fig. 106-A in use for years prove this unique design licks distortion and springing.

**LOOK at the Disc Holder** — It's the Slip-on Stay-on type originated by Jenkins. Correct protective depth prevents flaking or cracking of disc.

**LOOK at the Disc** — Easily renewed without removing valve from line. Made of compositions to suit various services . . . and *made by Jenkins*, the only maker of both valves and discs.

**LOOK at that Body** — Just compare wall thickness of this high tensile bronze body with any other valve. The factor of safety is many times higher than rating requires. See the curved diaphragm to protect seat from distortion by pipe strain. Note that the raised seat is higher to permit more reseating operations . . . and wider, so it won't cut into disc. Pipe threads are full length and clean cut.

**LOOK at this . . . for Throttling** — Just replace the disc nut with this Throttling Nut and a Fig. 106-A becomes well-suited to throttling service. This unique nut reduces the effects of wire drawing and its long legs restrict flow for accurate control. Many plants take advantage of this versatile valve to reduce valve and parts inventory.



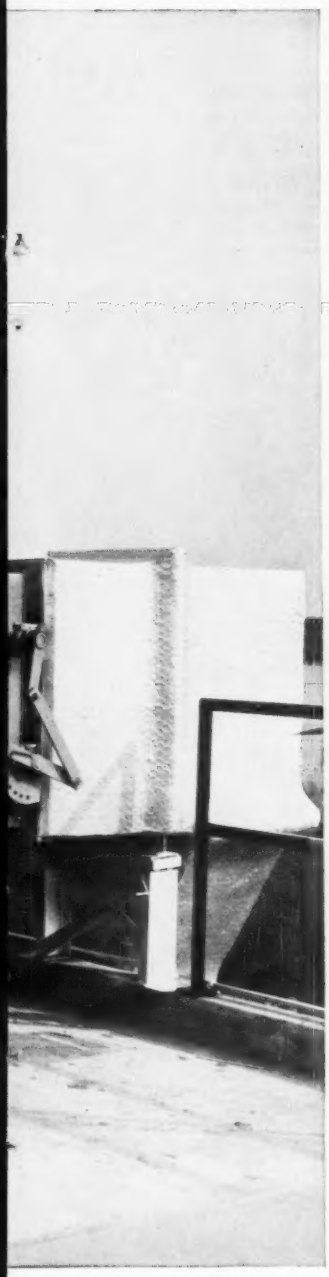
A Typical "Buffalo" Outdoor Forced Draft Installation.

"Buffalo" Mechanical Draft Fans are available with Forward Curved, Radial, Backward Curved and Airfoil Bladed Wheels.

**BUFFALO FORGE COMPANY,**

Buffalo Pumps Division
Canadian Blower & Forge

VENTILATING • AIR CLEANING • AIR TEMPERING • INDUCED DRAFT



# HERE'S MECHANICAL DRAFT PERFORMANCE OUT IN THE OPEN

Here is a typical "Buffalo" Forced Draft Fan engineered for outdoor service. Features "A" apply primarily to outdoor installations. Features "B" apply to Buffalo Forced Draft Fans in general.

**FEATURES "A":** Note first the air cooled bearing mounted on rigid cast iron pedestals and soleplates. Pressure from fan discharge provides air for cooling. Air passes through automotive type filter before entering oversize cooling passages and specially designed bearing sleeves. Use of air cooled bearings removes danger of freezing.

**SHIELD OVER INLET** helps keep rain and snow from fan air stream. SCREEN keeps loose objects from entering.

**RECIRCULATING AIR DUCT** brings preheated air to fan inlet for mixing with outside air to prevent corrosion in air heater at low boiler loads.

**PROPORTIONING DAMPERS** in this duct regulate and mix the air flow.

**FEATURES "B": HEAVY DUTY VARIABLE INLET VANES** deeply positioned in inlet for maximum horsepower reduction at reduced loads. Vanes are cantilevered, nothing obstructs inlet air flow. One lever accurately controls dampered combustion.

**INSPECTION DOOR** has quick opening latches for easy access to fan housing.

**OVERALL "Q" FACTOR CONSTRUCTION** is strictly heavy duty. Steel plate and rigid bracing contribute to maintenance-free fan life.

**BUFFALO, NEW YORK**

Buffalo, N. Y.
Co., Ltd., Kitchener, Ont.

"Buffalo"

EXHAUSTING • FORCED DRAFT • COOLING • HEATING • PRESSURE BLOWING

APCO PETROLEUM PRODUCTS

TIDEWATER OIL COMPANY
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76 UNION

*You, too—*

# CAN DEPEND ON ERIE CITY...

• In a field where continuous and economical operation is a prerequisite for success, dependability in steam generating equipment is mandatory.

Erie City Iron Works has hundreds of installations in the *petrochemical* field operating under all types of conditions. Dependence on Erie City products did not just happen . . . it was earned. Erie City engineers work closely with *petrochemical* engineers to produce a custom designed boiler or to adapt a standard unit to suit the particular requirements. Erie City's broad and most complete line of steam generating equipment is available for large central steam producing stations or portable steam producing units located in remote areas of the plant. When waste gases were available, Erie City's Fire Tube or Water Tube Waste Heat Boilers have turned these gases into economical steam.

When we say *"you can depend on Erie City for sound engineering,"* we point with pride to the leaders we serve.

TEXACO

GULF

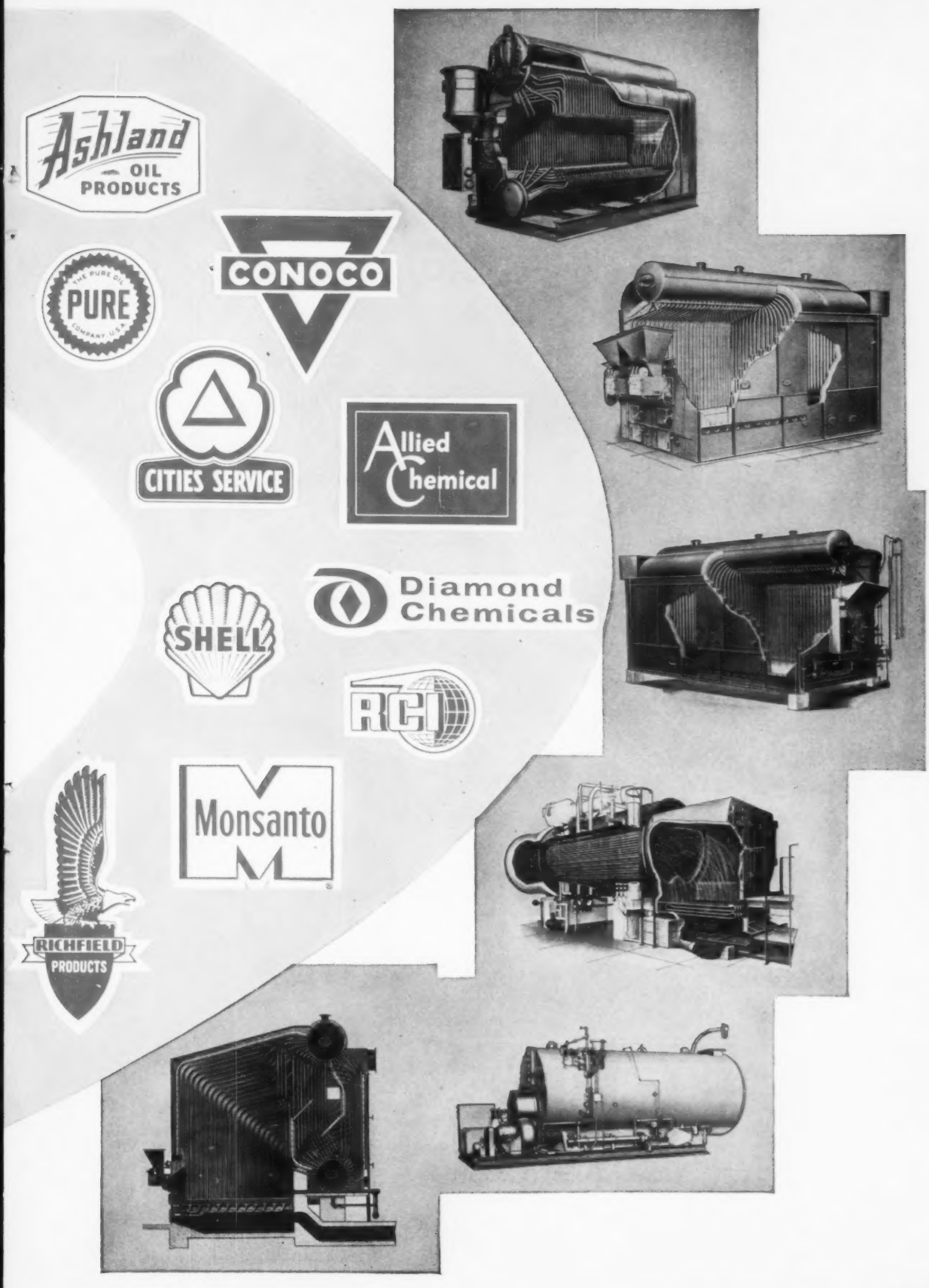
*Write for general catalog SB508-1G*

ERIE CITY Since 1840

*You can depend on Erie City for sound engineering*

**ERIE CITY IRON WORKS • *Erie, Pa.***

STEAM GENERATORS • SUPERHEATERS • ECONOMIZERS • AIR PREHEATERS • WASTE HEAT BOILERS
FIRE and WATER TUBE PACKAGE BOILERS • OIL and GAS BURNERS • STOKERS • PULVERIZERS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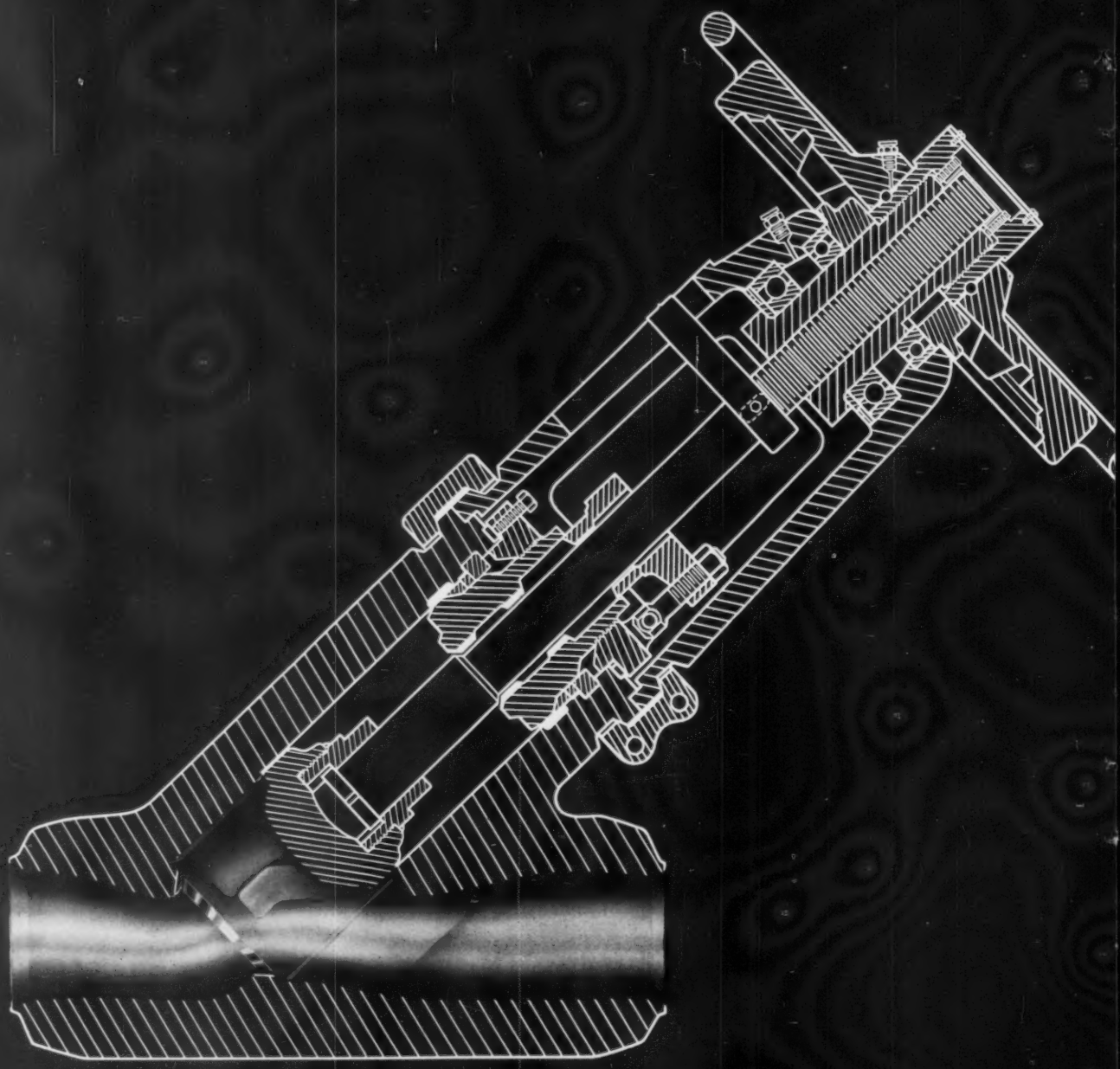
PRODUCTS



NEW EDWARD "FLITE-FLOW" VALVE

*What's New from Edward Valves, Inc.*

New Products . . . Problems and Solutions. . . Information on Steel Valves from Edward, Long-Time Leader in the Field!

# New Flite-Flow* Valve Cuts Pressure Drop 70%

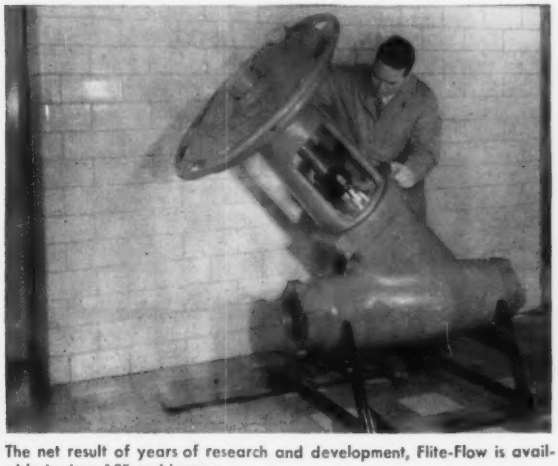
## . . . yet provides full globe valve tightness and repairability

Through basic characteristics of its design, only a hard seat globe-type valve can be depended upon to give drop-tight shutoff under high-pressure, high-temperature conditions. But conventional globe valves also produce serious pressure-drop problems—which intensify in the trend toward larger-capacity, higher-pressure plants with their higher-velocity flow rates.

Briefly stated, this was the problem given to Edward engineers. In their continuing program of valve development, these men had singled out turbulence in the flow path as a key area for study. They charted the effects of re-shaping flow passages . . . of shifting valve seat location . . . of *pre*-shaping the flow as it approaches the seat.

### *Low turbulence factor*

All tests confirmed that total pressure drop was least when turbulence was minimized in the three most critical areas: ahead of, at *and beyond the seat.* In the final design, flow approaching the seat is pre-shaped to provide a special "squirting action" which carries the fluid smoothly across the seat. The downstream side of the passage is shaped to receive this flow and send it on with a minimum of eddy and turbulence.



The net result of years of research and development, Flite-Flow is available in sizes 10" and larger.

The result is Flite-Flow, a globe valve with drop-tight shutoff *and* negligible pressure drop, as shown in the tables below:

**FEEDWATER SERVICE**

In 500-F, 3000-psi feedwater service on a 1,500,000 lb/hr unit, the following performance of 12-inch valves has been recorded:

Ordinary globe valve ... 10-15 lb drop
EDWARD FLITE-FLOW VALVE ... 2.1 lb drop
Good gate valve ... 1.0 lb drop

**STEAM SERVICE**

In 1050-F, 1900-psi steam service at 800,000 lb/hr through a 12-inch valve, the following performance has been recorded:

Ordinary globe valve...64 lb drop
EDWARD FLITE-FLOW VALVE ... 11 lb drop
Good gate valve . . . 2 lb drop

**OTHER IMPORTANT FLITE-FLOW FEATURES:**

- RESISTANCE TO THERMAL DIFFERENTIALS —a real design and metallurgical achievement.
- REPAIRABILITY OF SEATING SURFACES —while valve is in the line.
- PIPING VERSATILITY —fits any piping plan. Unique design assures accurate guiding of disk whether stem extends up, down or horizontally.
- IMPROVED OPERATING MECHANISMS —manual, pneumatic, electric.
- INTEGRAL SEAT CONSTRUCTION —inlaid stellite seat, machined and lapped in same set-up as body bore for perfect alignment.

**EDWARD VALVES, INC.**

Subsidiary of ROCKWELL MANUFACTURING COMPANY

1230 West 145th Street, East Chicago, Indiana

*Represented in Canada by*
LYTLE ENGINEERING SPECIALTIES, LTD., 360 Notre Dame St., W. Montreal 1, Que.

Edward builds a complete line of forged and cast steel valves from ⅛" to 18"; in globe and angle stop, gate, non-return, check, blow-off, stop-check, relief, hydraulic, instrument, gage and special designs; for pressures up to 7500 psi; with pressure-seal, bolted, union or welded bonnets; with screwed, welding or flanged ends.

*T. M. Reg. U. S. Pat. Off.

# now fully

## YARWAY REMOTE BOILER

**With** the addition of the new pressure compensator described on opposite page, full-scale accuracy of water level indication is provided not only at "working pressure" but *also at all other boiler pressures.*

The Yarway Remote Indicator now offers *completely accurate readings of the boiler water level under every operating condition.*

For complete information on Yarway Indicators and pressure-temperature compensation, write for Bulletin WG-1814 and new compensator supplement.

**YARNALL-WARING COMPANY**
100 Mermaid Avenue, Philadelphia 18, Pa.
BRANCH OFFICES IN PRINCIPAL CITIES

*NOTE: Ask about the application of Yarway Indicators for 900 psi and higher pressures under Boiler Code Case 1155 (two indicators in place of one of the two required gage glasses).*

YARWAY®

*...a good way*

# compensated *

# WATER LEVEL INDICATORS

### ADVANTAGES OF YARWAY PRESSURE COMPENSATOR

1. Compensating mechanism is applied to the Yarway indicator without change in internal construction of the indicator.

2. Well-known dependability of bourdon tube insures reliability and long life.

3. Trouble-free operation because linkage is simple and direct.

4. For maximum sensitivity, the indicator pointer is mounted on jewel bearings.

5. Rugged shock-resistant mounting carries weight of compensator mechanism without burdening the pointer mechanism.

6. Boiler conditions are readily simulated for check of instrument calibration at operating pressures, with remainder of indicator system under atmospheric pressure.

7. Application of pressure-temperature compensation for density changes in boiler water insures desired accuracy of level indication at all operating pressures and at all points on the pointer scale.

**Pressure compensator available on request, at extra cost.*

Model showing mechanism of Yarway Pressure Compensator. Placed between indicator operating and indicating elements, the compensator mechanism corrects the level indication by changing pointer travel to compensate for variation in water density due to changes in boiler pressure.

(Not shown) Yarway Remote Hi-Lo Alarm Signals (lights and/or horns), operated by the Indicator. May be placed at any location in the plant.

(Not shown) Yarway Electronic Secondary Indicator to provide duplicate reading at any other location. Same size and appearance as primary indicator.

*to specify remote liquid level indicators*

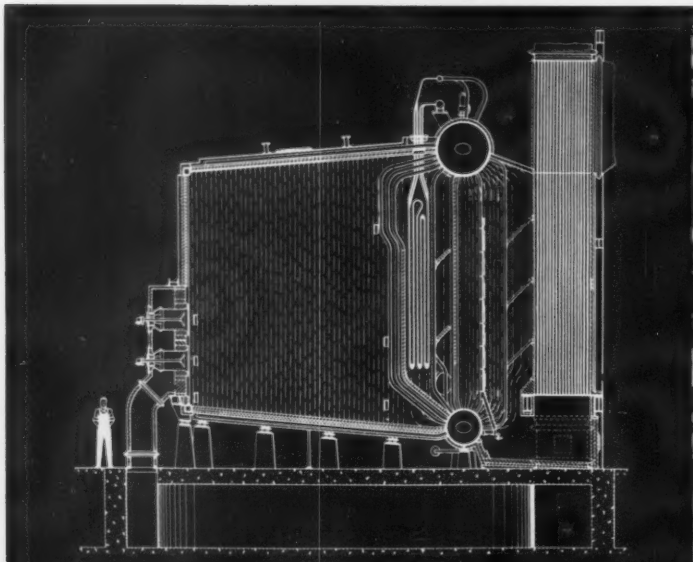
# C-E Boilers exceed at

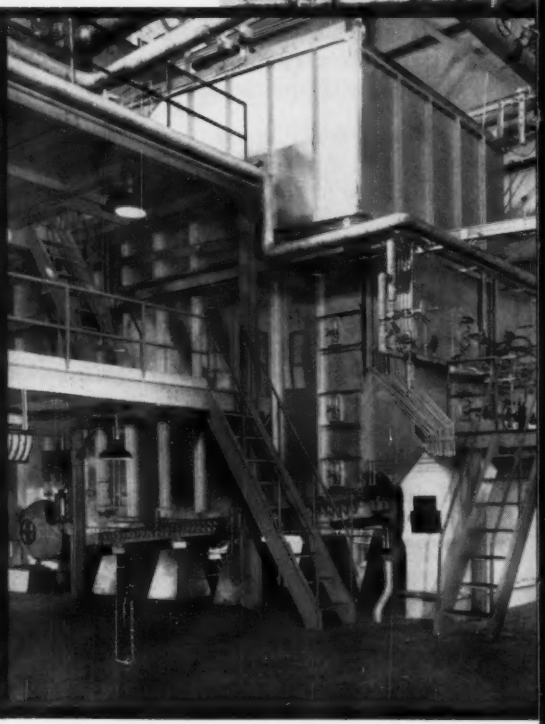
In a brewery, the demands placed upon its boilers can be rigorous indeed. At the Anheuser-Busch brewery in Newark, New Jersey, they provide steam for power generation, for processing and for numerous high-capacity instantaneous water heaters used in various brewing and bottling operations. Since brewing is essentially a "batch" process, steam demands fluctuate sharply and continuously. Yet the C-E Boilers installed at Newark have consistently exceeded performance guarantees and operate at an efficiency of 86%.

Mr. Herman Paradies, Superintendent of Utilities at the Newark brewery, has stated that it is not unusual for steam demands to rise from 80,000 to 130,000 pounds per hour in ten to fifteen seconds, and that the boilers have responded with nominal loss in pressure or temperature. This enviable record, which speaks well both for boiler design and for the skills of the power plant's operating management and staff, is one of which Combustion is proud.

When *you* need boilers, remember that C-E has a complete line of time-tested and service-proved designs and that there is a size and type which will fit your needs and serve you equally well.

C-164





(Right) One of the two C-E Type VU-50-B, oil-fired boilers in the Newark brewery (cross-section above). Each has a maximum continuous capacity of 100,000 lb per hr and produces steam at 550 psi and 750F. The floor in the foreground is chemically cleaned daily, polished twice weekly and completely refinished yearly.

# guarantees

# Anheuser-Busch, Inc.

The Newark, N. J., brewery of Anheuser-Busch, Inc. The seven year old power plant, left, is so spectacularly clean and neat that it has constituted a major attraction for professional and technical groups along the eastern seaboard. The popularity of these tours is such that, currently, reservations must be made two months in advance.

## COMBUSTION ENGINEERING

C-E

Combustion Engineering Building
200 Madison Avenue, New York 16, N. Y.

ALL TYPES OF STEAM GENERATING, FUEL BURNING AND RELATED EQUIPMENT; NUCLEAR REACTORS; PAPER MILL EQUIPMENT; PULVERIZERS; FLASH DRYING SYSTEMS; PRESSURE VESSELS; SOIL PIPE

# B. F. Goodrich

# rides with coal

## Tire manufacturer enlarges steam facilities; continues coal for economy, reliability

At its Oaks, Pa. plant, The B. F. Goodrich Co. uses steam principally for curing tires. When increased demand for its tires created the need for plant expansion in 1954, B. F. Goodrich found its original boiler plant could not supply sufficient steam. Completely new equipment was installed to increase capacity. But B. F. Goodrich continued to burn the economical fuel it had used in the past—coal.

In this modern coal-burning steam generation system, coal handling, ash disposal and the entire furnace operation are automatic. As a result of this modernization, fuel costs and manpower needs have been held to a minimum. And, in four years of operation, this installation has required only routine maintenance and repairs.

### Facts you should know about coal

You'll find that bituminous coal is not only the lowest-cost fuel in most industrial areas but up-to-date coal burning equipment can give you 15% to 50% more steam per dollar. Today's automatic equipment can pare labor costs and eliminate smoke problems. And vast coal reserves plus mechanized production methods mean a constantly plentiful supply of coal at stable prices.

### Technical advisory service

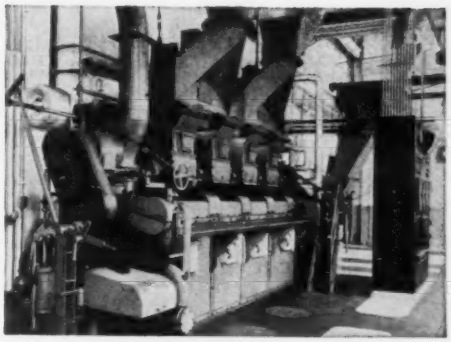
To help you with industrial fuel problems, the Bituminous Coal Institute offers a free technical advisory service. We welcome the opportunity to work with you, your consulting engineers and architects. If you are concerned with steam costs, write to the address below. Or send for our case history booklet, complete with data sheets. You'll find it informative.

### Consult an engineering firm

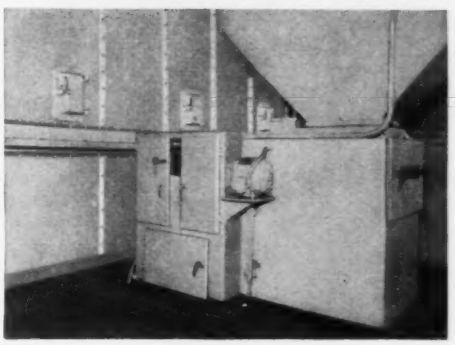
If you are remodeling or building new heating or power facilities, it will pay you to consult a qualified engineering firm. Such concerns—familiar with the latest in fuel costs and equipment—can effect great savings for you in efficiency and fuel economy over the years.

**BITUMINOUS COAL INSTITUTE**

Department P-07,
Southern Building, • Washington 5, D. C.



View of 100,000 lb/hr Wickes Boiler at B. F. Goodrich, fired by Detroit Rotograte Stokers. Coal is gravity fed from overhead bins through weighing equipment into stoker hoppers. Conveyor system is by Stock Equipment Co.

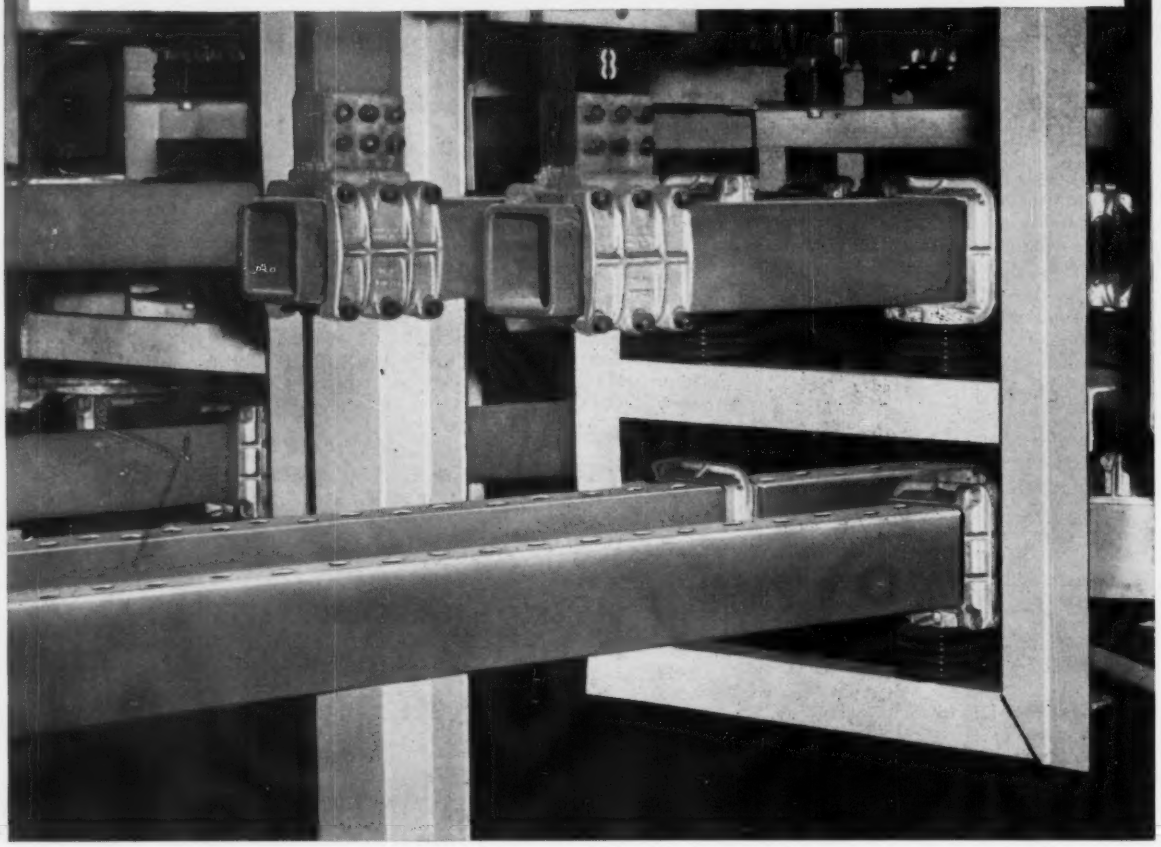


Shown here are overhead feeder and Stock coal-weighing equipment. This operation is all automatic. Coal goes from here to stoker.

Close-up of Stock coal elevator, conveyors and swinging spout used to stock out coal. Ash silo is part of United Conveyor ash handling system.

Coal storage area, showing level, compacted coal pile. Coal is stocked out from swinging spout by bulldozer, which later reclaims it to the track hopper for conveying into power plant.

# Another 100% Chase Square Copper Tube Bus Installation . . . in a major steel plant



## Over 200,000 lbs. of Chase® square copper tube Bus Conductor serve major tin plating line

Wherever—as in this tin plate line shown here—high amperage demands and safe current-handling capacities are a problem, there's a spot for Chase Copper Bus Conductor. Chase Square Copper Tube Bus Conductor has outstanding mechanical strength in all directions. Its flat surfaces can be tapped as easily as flat bars in making connections. Rounded corners eliminate excessive heating caused by skin effect. Ventilating holes can be provided in top and bottom surfaces, increasing current carrying capacity by about 20% for a given temperature rise.

Talk over your current-carrying needs—and Chase Square Ventilated or Unventilated Copper Tube Bus Conductor—with your own Electrical Contractor. Or call in your nearest Chase representative for consultation. You can reach him locally, or through Chase headquarters at Waterbury 20, Connecticut.

Chase® BRASS & COPPER CO.
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*The Nation's Headquarters for Brass, Copper and Stainless Steel*

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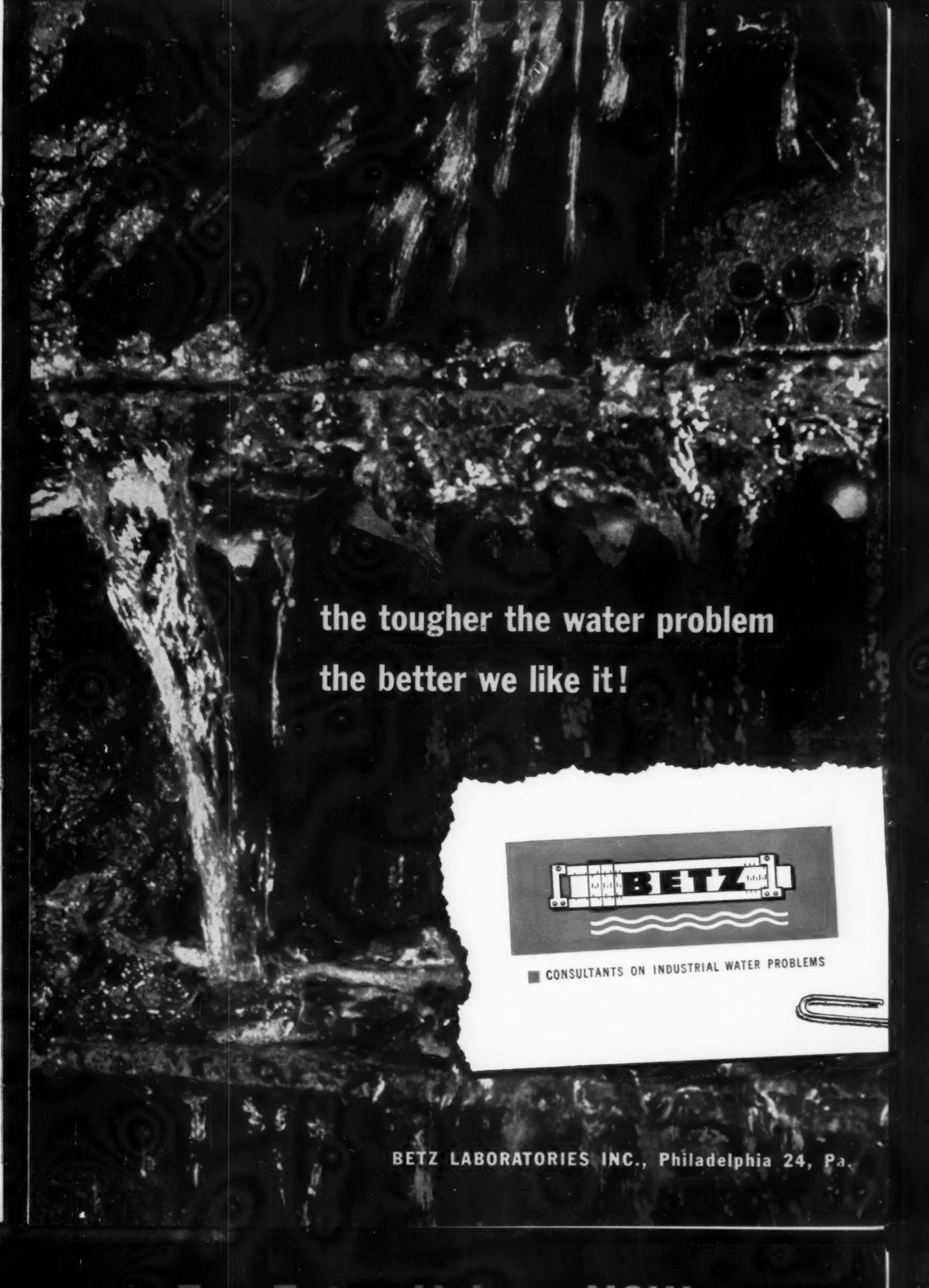
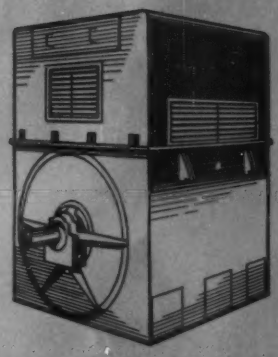

the tougher the water problem
the better we like it!
BETZ
CONSULTANTS ON INDUSTRIAL WATER PROBLEMS
BETZ LABORATORIES INC., Philadelphia 24, Pa.

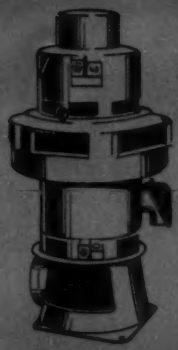
# OPERATION upturn

## Buy now for extra values

GENERAL ELECTRIC

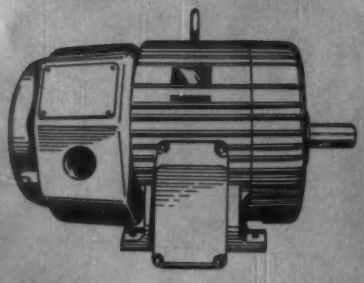


**NEW WEATHER PROTECTED MOTOR**—250 to 5000 hp—features high-up air intake and discharge. Fully tested. Install it, don't worry in bad weather. GEA-6571.

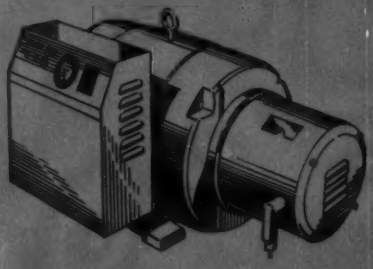


**NEW VERTICAL WEATHER PROTECTED MOTOR**—150 to 1000 hp—has withstood hurricane-force winds and water blasts. Windings remained completely dry.

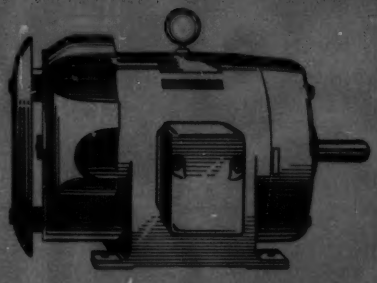
**DESIGN BY COMPUTER** of 150- to 5000-hp motors—provides more complete motor design analysis, helps speed quotations, and gives faster scheduling and shipment.



**NEW WOUND ROTOR MOTORS**—5 to 150 hp—average 50% lower inertia, up to 59% size reduction. Significant dollar savings can be achieved. GEA-6713.



**NEW SYNCHRONOUS GENERATOR**—40 to 150 kw—eliminates brushes, slip rings and commutators. GEA-6795. 175 to 300-kw ratings have static exciter. GEA-6809.



**NEW TEFC TEXTILE MOTORS**—7½ to 25 hp—feature exclusive new endshield and fan designs for optimum performance in lint-laden textile atmospheres. GEA-6795.

# For Extra Values NOW...

# Buy General Electric Motors

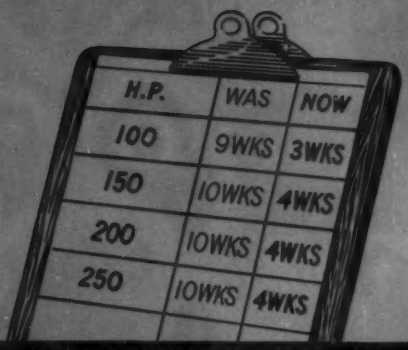
"Operation Upturn" is General Electric's program to acquaint you with new products and services of such significance that you can justifiably "Buy Now for Extra Values."

During the past year, literally hundreds of "Extra Values" have been added to G-E motors. And, even with significant increases in manufacturing costs, motor and generator prices have been advanced only slightly. Here are just a few typical Extra Values for you to consider. For more details, write for listed bulletins or call your nearby G-E Apparatus Sales Office or Distributor. General Electric Co., Schenectady, N.Y.

802-1

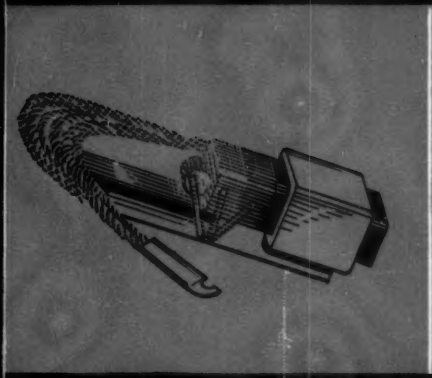
## GENERAL ELECTRIC

**OVER 40 QUALITY CHECKS** keynote the rigorous quality control programs operating today to help assure top performance from entire General Electric line.

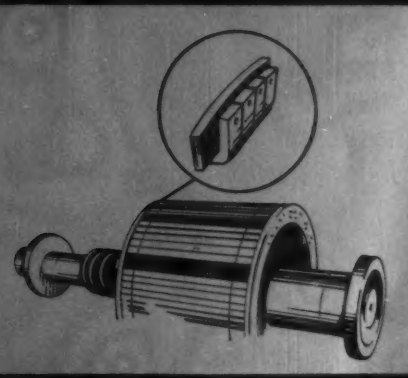



**50% CUT IN SHIPMENT TIME** for 100 to 350-hp motors has been achieved with new parts inventory system. Shipping time is now reduced to 4 and 3 weeks.

**NEW ACOUSTIC TREATMENT** for large high speed motors reduces high-frequency "whine" to a quiet hum, improving employee comfort, efficiency. GEA-6571.



**NEW "CONSTANT PRESSURE"** carbon brush holder eliminates adjustment, offers up to 50% longer wearing length, reduces large motor maintenance. GEZ-1158.



**FLEXIBLY-CONNECTED WINDINGS** improve starting performance, permit wider application of large G-E synchronous motors to high-inertia drives. GEA-6620.

**IMPROVED BONDED FIELD POLES** for low-speed synchronous motors. Bonding technique continually advanced in large motor construction since 1938 inception.

ACTUAL SIZE

## GET THE MOST FOR YOUR

# BTU DOLLAR

## *...with Nicholson steam traps*

You get top operating temperature per dollar of fuel consumption . . . when you use the Nicholson steam trap. This trap purges all air and non-condensibles from pipes and equipment *continuously* . . . not just at warm-up time. Your boiler doesn't have to operate at top capacity —all the time—to obtain top steam temperature where and when you need it.

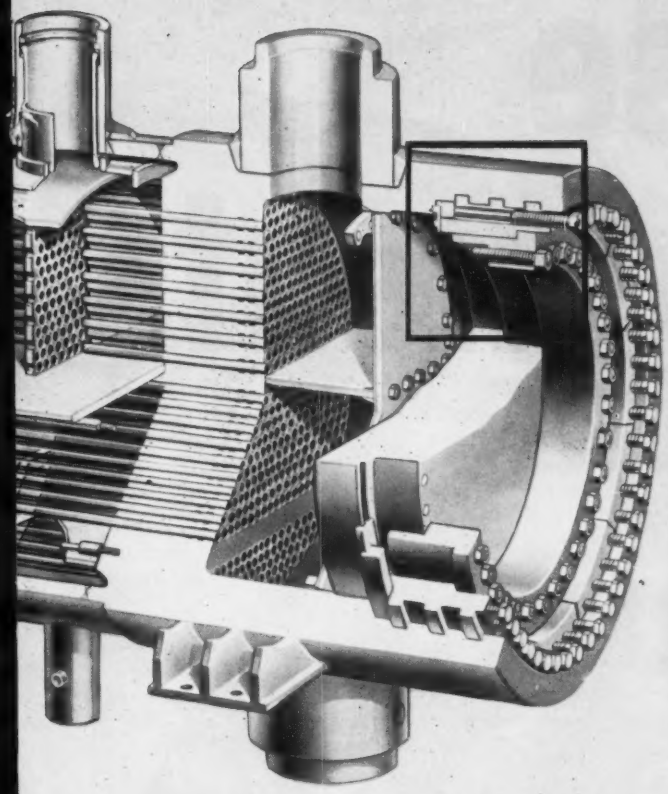
Make full use of your BTU dollar, with Nicholson traps. They have only one moving part . . . a valve that operates on just a few degrees of temperature differential.

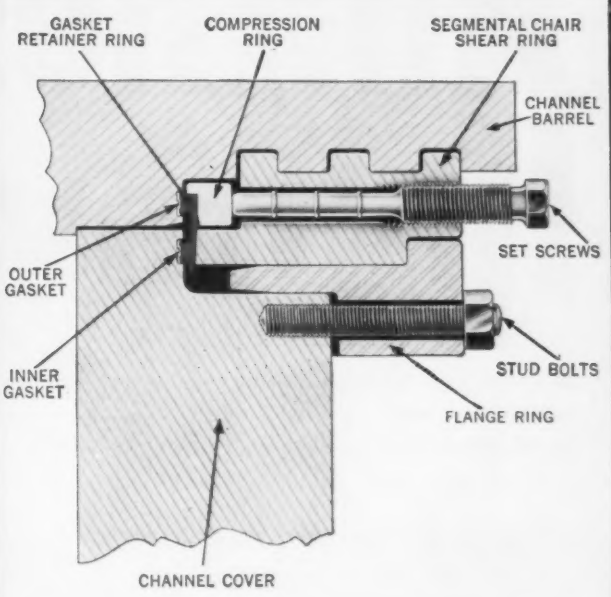
In your steam generation, and in your steam utilization . . . Nicholson traps will save you money. You can try one . . . without obligation! W. H. Nicholson and Company, 12 Oregon St., Wilkes-Barre, Pa. Sales and Engineering Offices in 98 principal cities.

**NICHOLSON**

*of Wilkes-Barre*

ALCO FEEDWATER HEATERS






Detail of Type "D" closure on ALCO high-pressure feedwater heater shows simplicity of dismounting and reassembly, isolation from contained condensate.

# TWO MILLION HOURS OF OPERATION PROVE ALCO'S TROUBLE-FREE CLOSURE

The ALCO Type "D" closure, standard on all ALCO high-pressure feedwater heaters, has now rolled up more than two million hours of operation in power plants. During this time, the positive mechanical-locking design of the closure has turned in an outstanding record of trouble-free performance.

In addition, the ALCO Type "D" closure provides many other important operational advantages. The closure's locking strength is uniform. Screwed fastenings and locking devices are dry and cannot be corroded by condensate. If maintenance of tubes is necessary, the closure is easily demounted with hand tools for full access to tube ends. Reassembly is quickly accomplished with the same hand tools. For added savings, no costly and time-consuming pressure welding is necessary.

Specialists in any ALCO sales office will be happy to discuss with you in detail the design, construction and many advantages of the ALCO Type "D" closure on feedwater heaters. For an informative brochure, write ALCO Products, Inc., Dept. 135, Schenectady 5, New York.

ALCO

**ALCO PRODUCTS, INC.**

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SALES OFFICES IN PRINCIPAL CITIES

*Locomotives · Diesel Engines · Nuclear Reactors · Heat Exchangers · Springs · Steel Pipe · Forgings · Weldments · Oil-Field Equipment*

**In the last two years...**

# All These Improvements

**Whether your fly ash problems require a straight precipitator, a combination unit, or a mechanical collector alone, you can count on an economical solution from Research-Cottrell.**

**1. New Cyclo-trell**—Sets new standards for collection efficiency and gas volume capacity. Double deck arrangement improves gas distribution to precipitator and conserves valuable space. Collecting tube is erosion resistant.

**Cottrell Automation System**—Higher "around-the-clock" collection efficiency, without manual adjustments. New electronic methods provide continuous optimum energization.

**2. Opzel Collecting Electrodes**—New design cuts cost, provides optimum precipitation zone with better gas flow and electrical conditions.

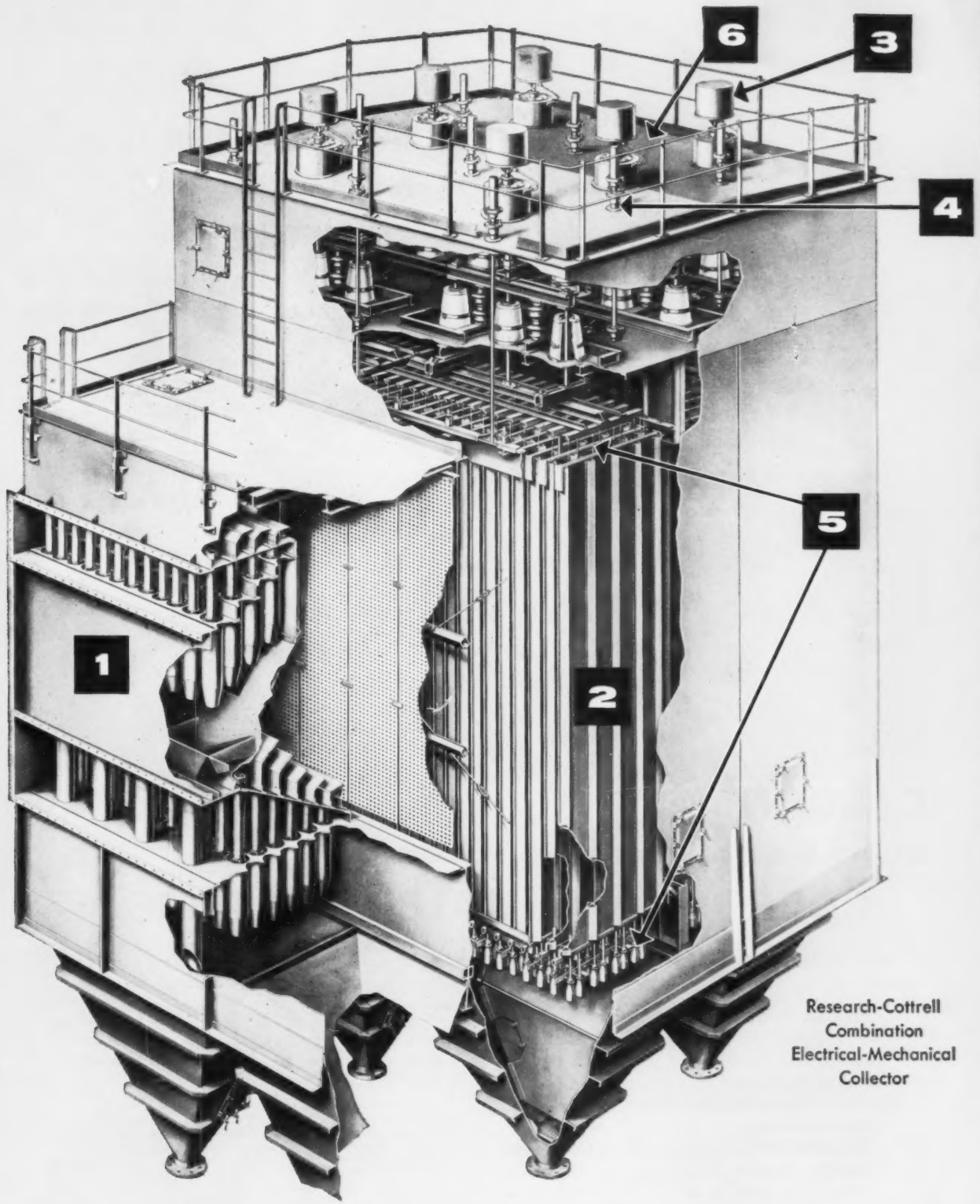
**3. New Discharge Electrode Rappers**—Available in air, electric, vibrating or impact type. Cycle and intensity are easily adjusted to maintain highest collection efficiency.

**Silicon Rectifiers**—New, hermetically sealed rectifiers last as long as the precipitator—without maintenance. Rectification efficiency is 96% to 99% with no voltage drop due to age.

**4. M. I. Rappers on Roof**—New arrangement provides better rapping and easier access to automatically controlled rappers, without additional expensive platforms.

**5. New Discharge Electrodes**—No. 430 stainless steel discharge electrodes are individually hung for easier access from top to bottom. Entire collecting plate surface is effective because the discharge wires extend well beyond the top and bottom of the plate.

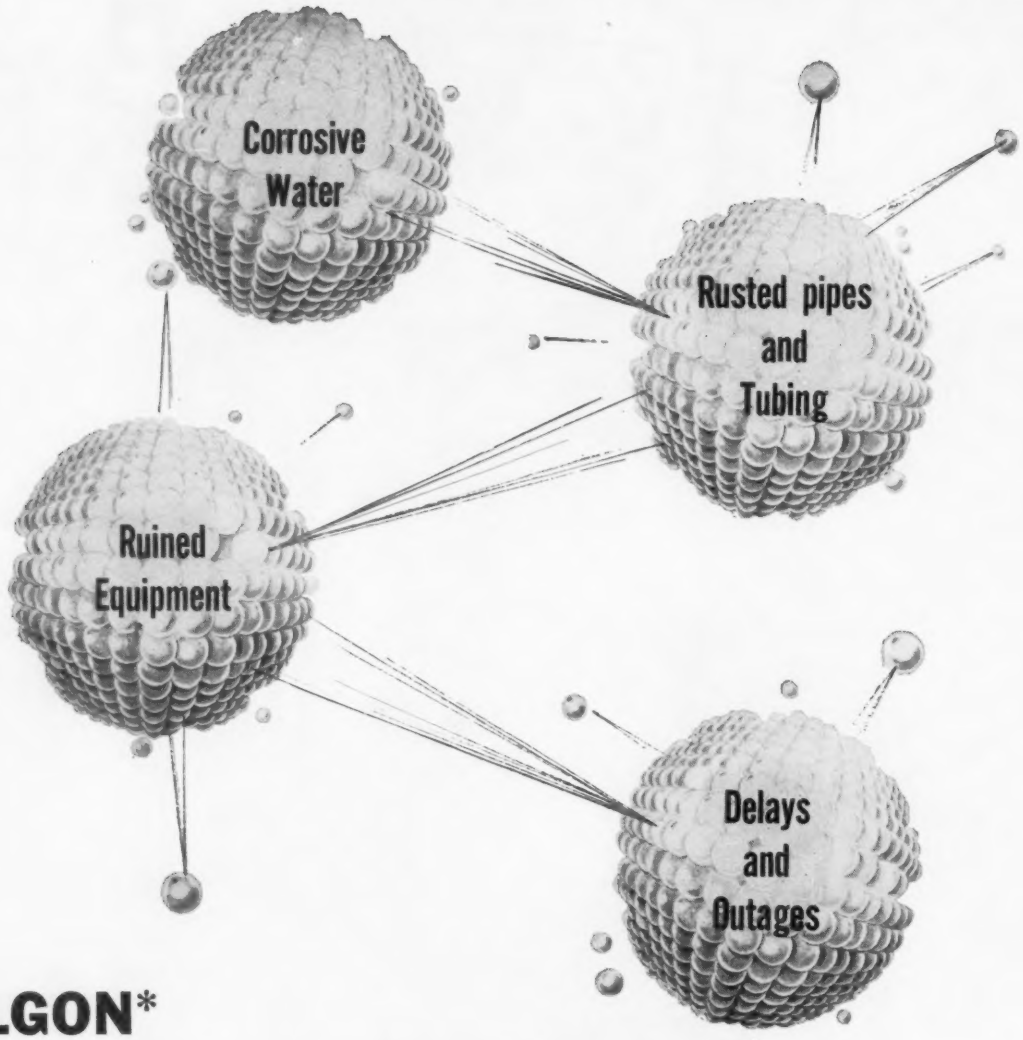
**6. New Top Constructions**—Insulator compartments or steel housing over the entire roof are available. Designed for low insulator maintenance; bushings can be replaced without disturbing high tension frame. Top housing provides "out-of-weather" working space for maintenance.




Research-Cottrell
Combination
Electrical-Mechanical
Collector

# Research-Cottrell

RESEARCH-COTTRELL, INC. Main Office and Plant: Bound Brook, N. J. • 405 Lexington Ave., New York 17, N. Y. • Grant Building, Pittsburgh 19, Pa. • 228 N. La Salle St., Chicago 1, Ill. • 58 Sutter Street, San Francisco 4, Calif. • Research-Cottrell (Canada) Ltd., 33 Bloor Street East, Toronto 5, Ontario.




# CALGON*

## stops the chain-reaction costs of

# CORROSION in WATER SYSTEMS

Corrosion in any part of a cooling or process water system can touch off a chain reaction of damage and costly delay. Repair or replacement of equipment plus production losses far exceeds the cost of adequate protection against corrosion damage.

To avoid costly damage, call on Calgon Engineering Service. Protection for the entire system, from cooling towers on through, is set up. Iron and steel surfaces can be given fast and more complete protection with Calgon* composition TG, remarkable for its accelerated film forming ability. Copper or copper alloy corrosion can be inhibited with Coraid, which is effective at both high and low pH values.

Experience with all types of industry in all parts of the country is at your disposal; a letter or phone call will put a Calgon engineer to work on *your* problem.

*Calgon is the Registered Trademark of Calgon Company for its sodium phosphate glass (sodium hexametaphosphate) products. The use of Calgon for the prevention of corrosion is covered by U.S. Patent 2,337,856.

**CALGON COMPANY**

DIVISION OF **HAGAN** CHEMICALS & CONTROLS, INC.
HAGAN BUILDING, PITTSBURGH 30, PENNSYLVANIA
DIVISIONS: CALGON COMPANY, HALL LABORATORIES
IN CANADA: HAGAN CORPORATION (CANADA) LIMITED, TORONTO

# CHOOSE STOKER FIRING FOR ECONOMY AND SATISFACTION

## Coal, Burned With a DETROIT STOKER Offers Many Advantages, Proven By Thousands of Installations

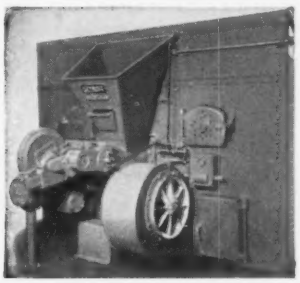
- Assured Fuel Supply
- Provides Steam At Lowest Cost
- Dependable—Noted For High Availability
- Maintenance Expense Low
- Requires Little Power For Operation

One of these Detroit Underfeed or Spreader Stokers will save you money—they are backed by over a half century of experience.

### DETROIT ROTOSTOKER

Spreader stoker with OVER-THROW ROTORS that distribute the fuel uniformly in the furnace. Fine particles burned in suspension and coarse coal, burned on the grate. Four types of grates are available. Roto-Stokers burn successfully an extremely wide range of fuels without any special preparation. In combination with coal, RotoStokers also successfully burn wood and other refuse.

### DETROIT UNISTOKER



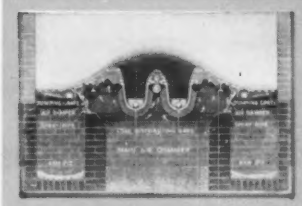
Plunger feed, side-cleaning stoker is available in various sizes for 125 to 250 horsepower boilers. Full-housed blower either motor or steam turbine driven, mounted at stoker front. Adjustable Feed provides for either manual or automatic coal feed control.

### DETROIT ROTOSTOKER TYPE C-C

*(Continuous Cleaning)*

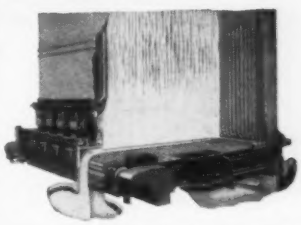
**An important addition to the comprehensive "Detroit" line of spreader stokers. Readily applied to small and medium size steam generators approximately 5,000 to 75,000 pounds of steam per hour. The continuous cleaning grates automatically discharge the ash at the front for easy removal. No basement needed.**

### DETROIT DOUBLE RETORT STOKER



**A multiple retort stoker having two retorts, with the side-cleaning feature requiring no basement. Now available with Detroit Adjustable Feed Coal Feed Control. For medium sized boilers.**

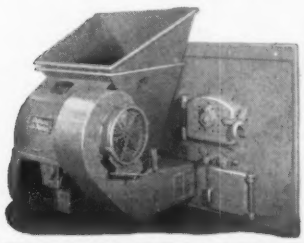
### DETROIT ROTOGRATE STOKER



Spreader stoker with FORWARD MOVING GRATES for medium and large boilers up to approximately 400,000 pounds of steam per hour. Screenings or crushed run-of-mine coal used without grinding or pulverizing. Successfully burns a wide range of fuels, including lower grades of Bituminous Coal and Lignites . . . with preheated air if desired. Higher burning rates for longer periods with low excess air and without slagging or clinkering difficulties. Combustible in ash is unusually low.

### DETROIT LOSTOKER

*Has Detroit Adjustable Feed (Coal Feed Control).*



A complete firing unit. Compact—single retort—mechanically driven—plunger feed—side-cleaning design. Many sizes and capacities for various types of boilers. Simple, accessible, dependable. A great coal saver.

## DETROIT STOKER COMPANY

**Main Office and Works, Monroe, Mich.**

**District Offices or Representatives in Principal Cities**

***INVESTIGATE DETROIT STOKERS — IT'S THE ROAD TO ECONOMY AND SATISFACTION***

Steel stack and breeching being gun-lined with refractory concrete (made with LUMNITE calcium-aluminate cement) at United Illuminating Company, New Haven, Conn. Gunite Contractor: Pressure Concrete Co., Newark, N. J.

# ATLAS LUMNITE in stack linings . . . protects steel shell from corrosion and heat

- Refractory concrete linings (made with ATLAS* LUMNITE cement) resist the corrosive action of flue-gas condensate which forms on stack surfaces.
- Concrete retains high strength under continued exposure to heat and frequent heating-cooling cycles.
- Placement is fast, easy, economical – by guniting, pouring or plastering.
- Downtime is reduced because concrete reaches service strength in 24 hours.

For maximum convenience, use castables made with LUMNITE* cement. These are packaged mixtures, ready for use. Simply add water, mix and place. Made and distributed by leading manufacturers of refractories.

UNIVERSAL ATLAS CEMENTS

Write for "Lumnite Mortar Manual," describing gun-applied linings: Universal Atlas, 100 Park Avenue, New York 17, N. Y.

L-175

**Universal Atlas Cement Company**

Subsidiary of **United States Steel**

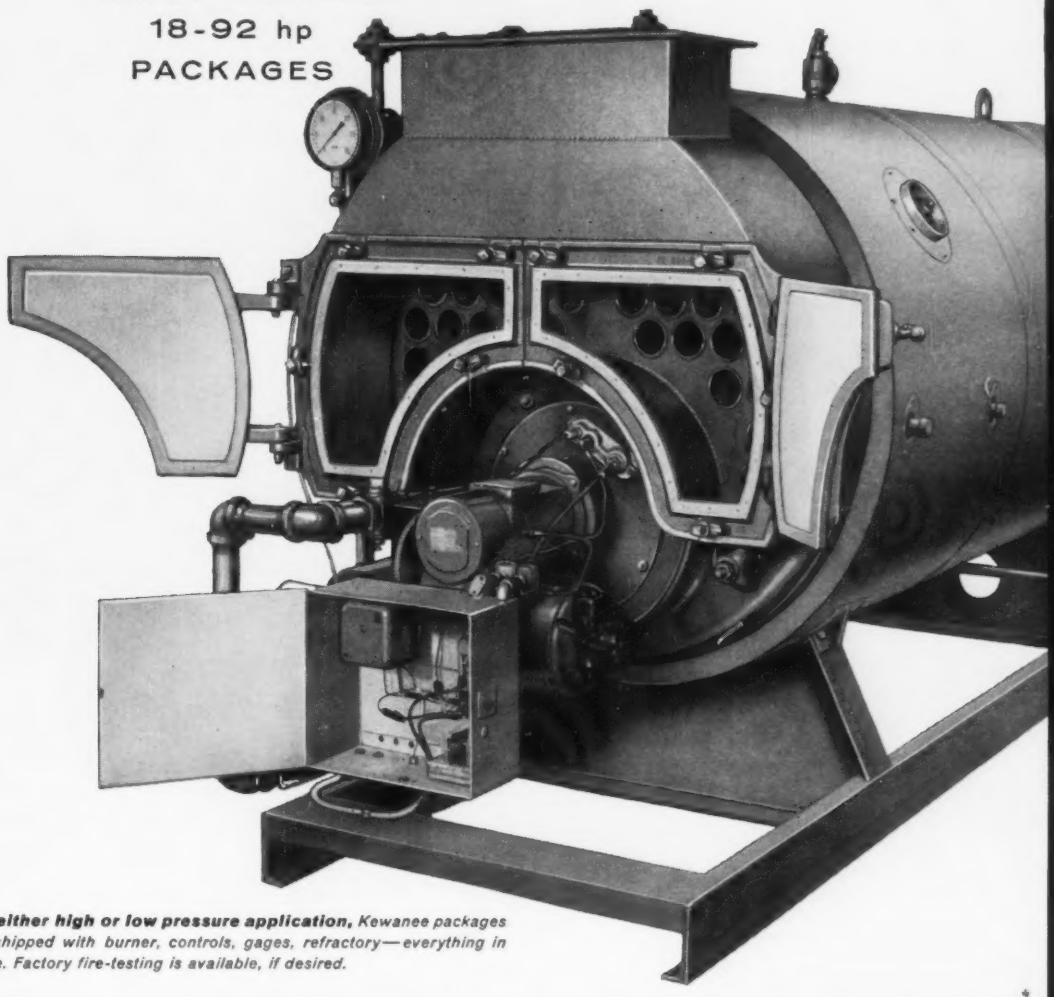
USS * TRADE MARK

**OFFICES:** *Albany · Birmingham · Boston · Chicago · Dayton · Kansas City · Milwaukee · Minneapolis · New York · Philadelphia · Pittsburgh · St. Louis · Waco*

NEW . . . AND *NEEDED*

# KEWANEE®

READY-TO-FIRE
18-92 hp
PACKAGES



***For either high or low pressure application,*** *Kewanee packages are shipped with burner, controls, gages, refractory—everything in place. Factory fire-testing is available, if desired.*

Put Kewanee quality and the package principle together on your next "under 100 hp" project. If it's a high pressure job, choose from 8 packages ranging from 18 to 92 hp. For low pressure applications, Kewanee packages start at 606,000 Btuh and end, eight sizes later, at 3,091,000 Btuh.

These are famous Kewanee Scottie Jr. Boilers factory-teamed with Kewanee Burners for oil, gas or combination oil-gas firing. They arrive on the job ready to fire as soon as they are connected to fuel, water, steam, power and vent. Fuel changeover, in combination firing, is fast and can even be handled by automatic controls. Forced-draft firing eliminates a stack. No unit is higher than an 8-foot standard ceiling.

New literature has recently come off the press on these new Kewanee packages. If you haven't seen it, send the coupon at right to: AMERICAN-STANDARD, KEWANEE BOILER DIVISION, 111 Franklin Street, Kewanee, Illinois.

American-Standard
Kewanee Boiler Division
111 Franklin Street • Kewanee, Illinois

KEWANEE 1958 90th year 1868

Please supply literature on the following Kewanee Boilers

☐ high pressure . . 18 to 92 hp, 125-150 lb wp

☐ low pressure . . . 606 to 3091 MBtuh, 15 lb steam - 30 lb water

Name _____

Firm _____

Street _____

City _____ Zone ____ State _____ 7

AMERICAN-Standard
KEWANEE BOILER DIVISION

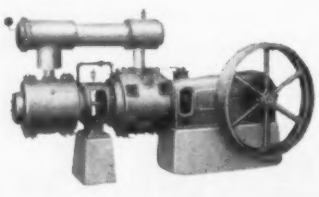
*The class T compressor is one of a complete line of CP compressors for process work. Other types available in sizes to 5,000 HP for pressures to 15,000 psig, with motor, steam or belt drive.*

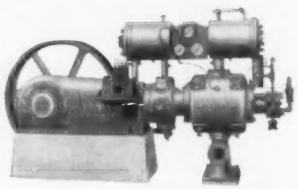
Chicago Pneumatic

8 East 44th Street, New York 17, N. Y.

AIR AND GAS COMPRESSORS • VACUUM PUMPS • PNEUMATIC TOOLS • ELECTRIC TOOLS • DIESEL ENGINES • ROCK DRILLS • HYDRAULIC TOOLS

*Two-stage class TCB-2 compressor for pressures up to 500 lbs.*



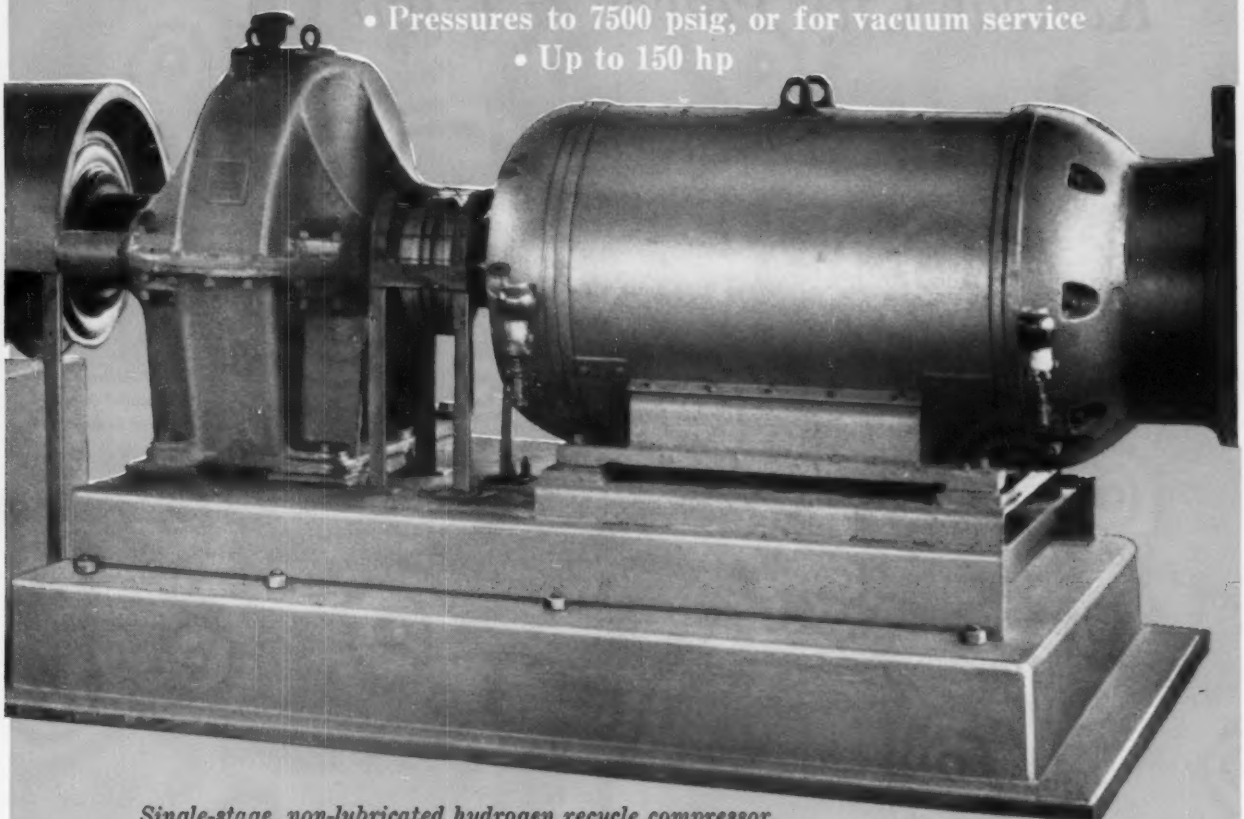


*Typical three-stage class T compressor for pressures up to 2,500 lbs.*

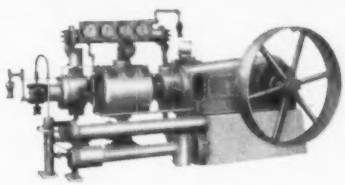
# Class T

## PROCESS COMPRESSORS

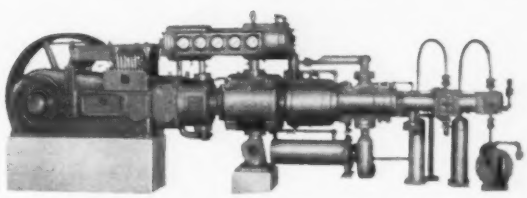
- Pressures to 7500 psig, or for vacuum service
- Up to 150 hp



*Single-stage, non-lubricated hydrogen recycle compressor.*



*TCB-4 four-stage, straight-line compressor suitable for 6,000 lbs. discharge pressure.*

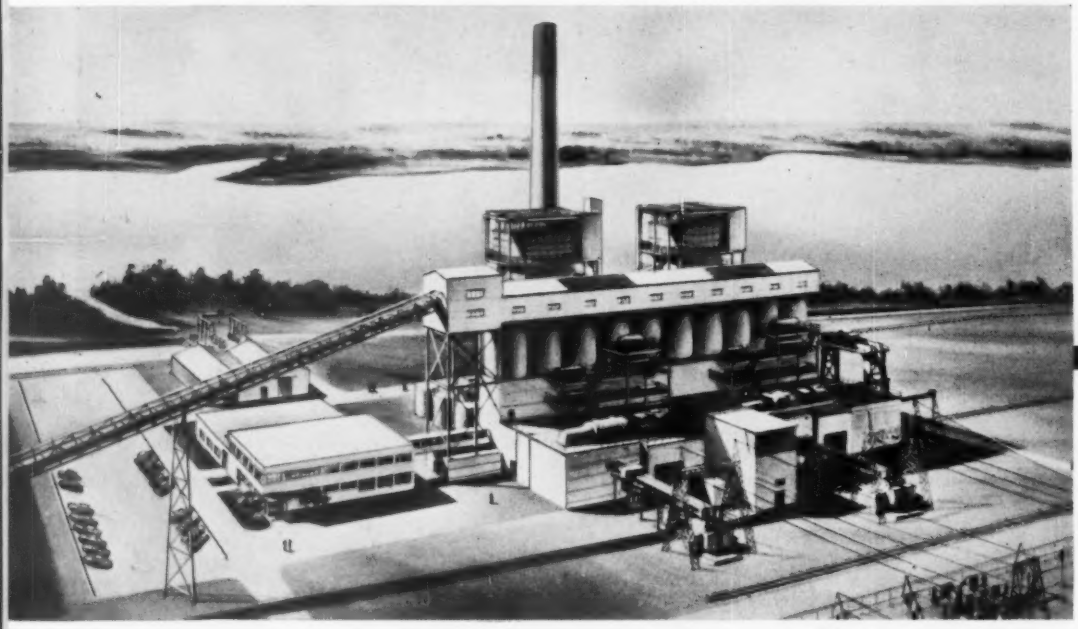


*Five-stage compressor designed for 7,500 lbs. service.*

# CHAPMAN VALVES

*are doing a job for*

*Kansas City Power & Light Co.*



(Left) New Montrose Station, located 60 miles Southeast of Kansas City.

Ebasco Services Incorporated, acted as Engineers and Construction Managers for Kansas City Power & Light Co.

Here's a good example of what Chapman Valves can do for power plants.

In the Kansas City power plants, pressure requirements are varied . . . from 2500# to 150# psi. And Chapman Valves are meeting the specified pressure-temperature ratings . . . Chapman alloy steel gate, globe, swing check and tilting disc check valves . . . Chapman Valves, both hand and motor operated . . . Chapman Valves with welded body and bonnet or pressure seal.

In Kansas City, you'll find Chapman Valves in the 332,000 KW Hawthorn Station. You'll find them in the first brand new 156,250 KW unit at Montrose Station. You'll find them in the second Montrose unit scheduled for completion in 1960.

The reason for all this makes an interesting story. Chapman goes all out . . . 100 per cent . . . to meet valve requirements in a true engineering way. Upon request, one of our engineers will gladly talk to you about it.

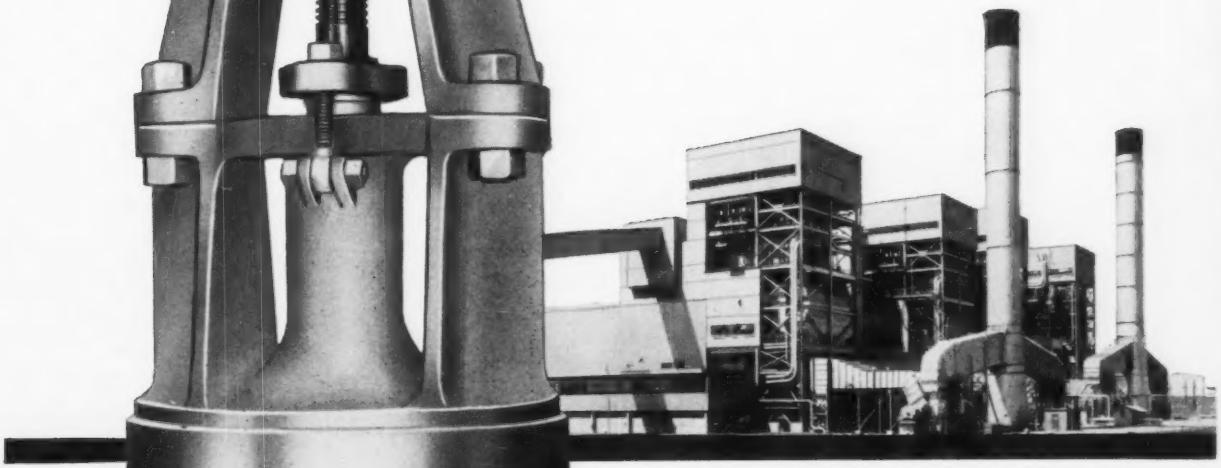
*The* **CHAPMAN** *Valve Manufacturing Co.*

*INDIAN ORCHARD, MASSACHUSETTS*

*For over 75 years, Chapman has been designing, developing, improving, building, testing and delivering valves to meet usual and special requirements for power plants, water works, chemical plants, refineries and industrial use.*

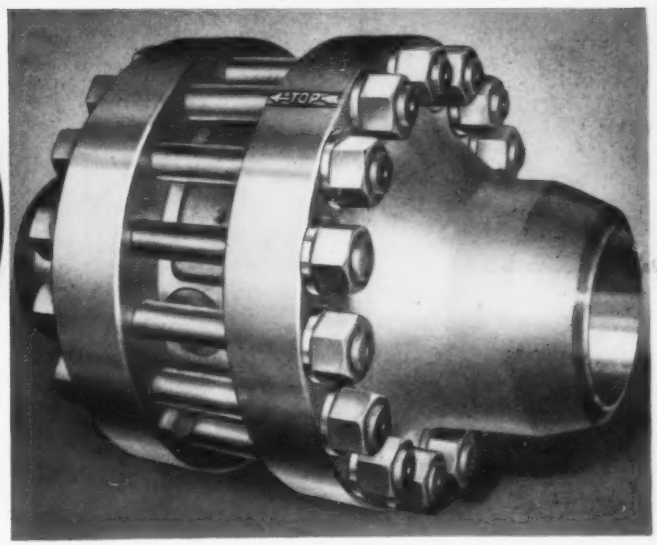
# *Under pressures from 2500# to 150# psi . . .*

Typical of the Chapman 2500# psi alloy steel valves used in Kansas City. Has welded body and bonnet connection and is equipped for motor operation.



The Hawthorn Station of Kansas City Power & Light Co. located in Kansas City, Mo.

Chapman 3-piece tilting disc check valve with welding ends.



ALLIS-CHALMERS STEAM TURBINE-GENERATOR UNITS

# 4 Basic Types for

## Select from Condensing . . . Non-Condensing . . . Condensing Automatic Extraction . . . and Non-Condensing Automatic Extraction Types

ALLIS-CHALMERS WA-Series steam turbine-generator units are built in NEMA ratings from 2000 through 10,000 kw, and AIEE-ASME preferred standard ratings up to and including 16,500 kw.

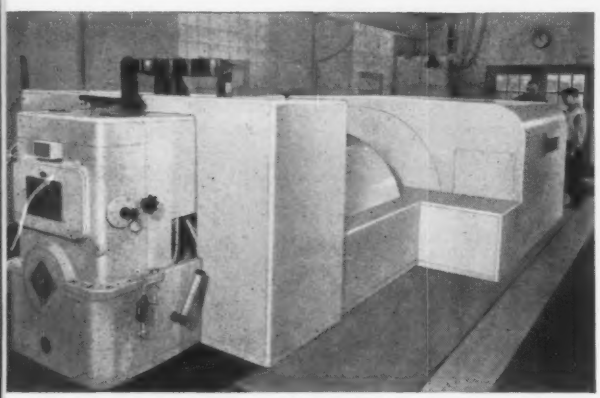
Both utility and industrial service requirements can be filled from this broad line of modern machines.

Turbine, generator and exciter are carefully engineered to operate as a unit. Oil piping and generator gas coolers are located above the floor line to eliminate trenching and duct-work . . . facilitate installation.

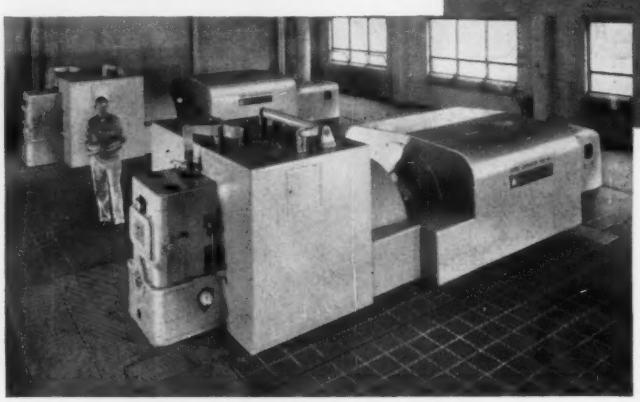
Other features include a self-contained lubrication system, metallic labyrinth-type steam seals, and unit shipment of assembled machine.

For detailed information and help in selecting the type and size unit for your requirements — from 2000 to 500,000 kw, call your nearby A-C office or write Allis-Chalmers, Power Equipment Division, Milwaukee 1, Wis.

**Condensing** — This 16,500-kw steam turbine-generator is hydrogen cooled, and is typical of the largest WA-Series units.



**Non-Condensing** — Power and process steam for a paper manufacturer are supplied by this Allis-Chalmers 4000-kw unit.



**Non-Condensing Automatic Extraction** — These two 3000-kw units in power plant of hospital provide by-product power. Process steam is used for laundry, cooking, heating, and sterilizing.

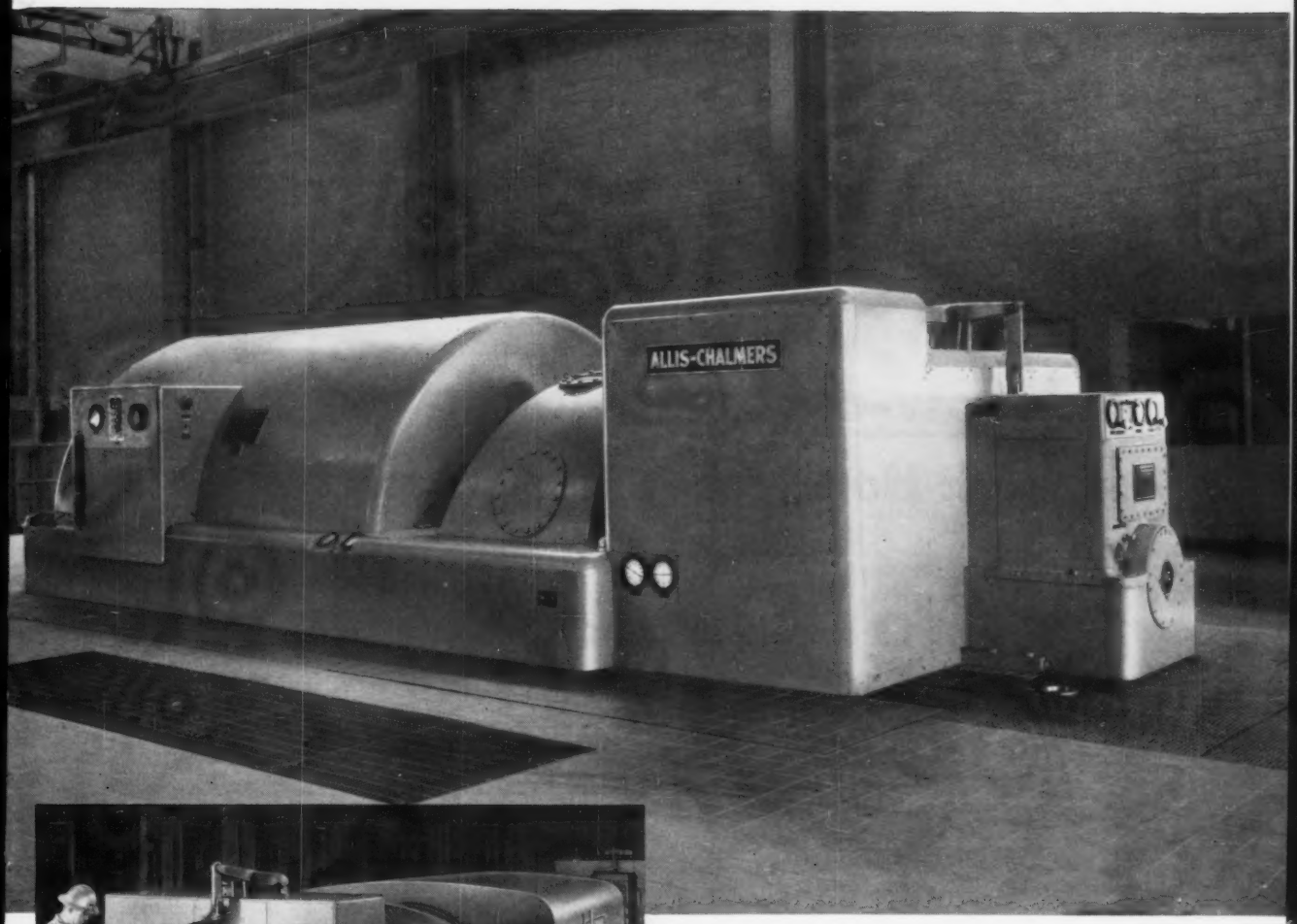
A-C ALLIS-CHALMERS

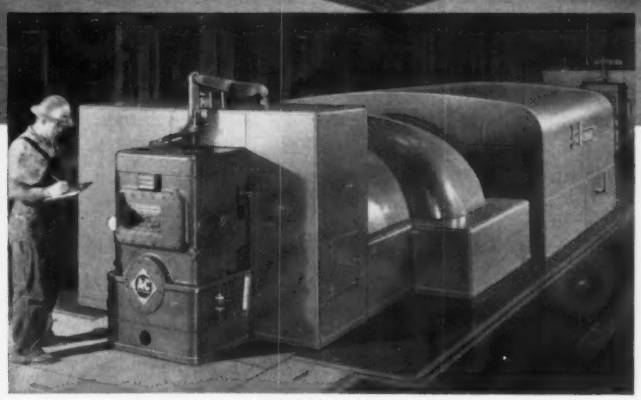
**ALLIS-**

A-5666

2000 to 16,500 Kw

# Modern Power Plants

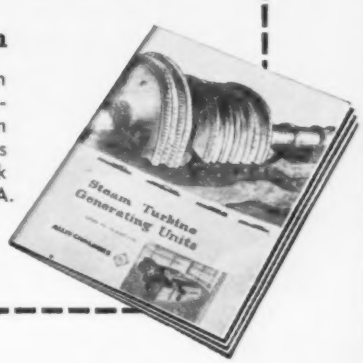


**Condensing Automatic Extraction** — Power is generated as a by-product of process steam needs at this chemical company. Two 5000-kw Allis-Chalmers steam turbine-generators are used.

**New Bulletin**

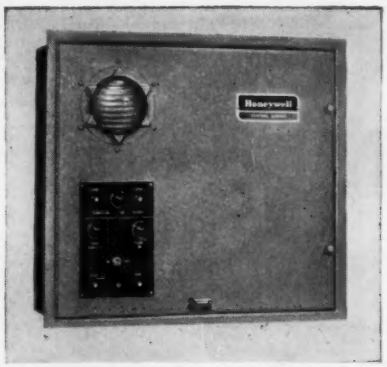
New 40-page bulletin provides detailed engineering information about Allis-Chalmers WA-Series units. Ask for Bulletin 03B7654A.




# CHALMERS

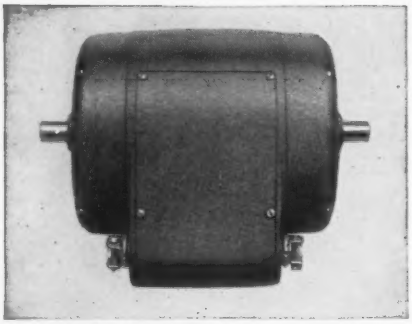
**PRESSURE CONTROLLERS** for high or low-limit cutoff or signalling, or for control of pressure and vacuum in many ranges from 0 to 1000 psi.

**REMOTE BULB TEMPERATURE CONTROLLERS** for high or low-limit cutoff . . . signalling . . . and automatic on-off, two-position, floating or proportional control with electrically or pneumatically operated valves, dampers, refrigeration units and similar equipment.

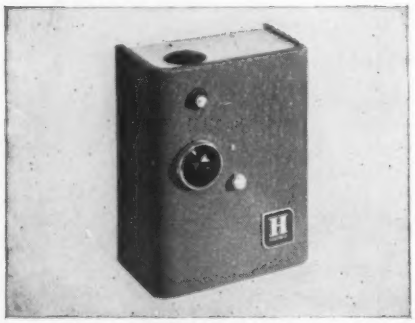



***PROTECTOGLO* FLAME SAFEGUARDS** instantly detect flame failure in gas or oil fired burners, and immediately shut off fuel supply, sound an alarm, and perform other functions to guard against explosion hazards.

# Add low-cost automation ...with Honeywell industrial controls



**INDUSTRIAL MOTORS** for electrical operation of valves, dampers and auxiliary switches.



**ALARM SILENCING RELAYS** permit an alarm to be silenced, and light an integral red light until an unsafe condition has been corrected. Relay automatically resets the alarm when safe conditions are restored.

You don't have to spend a lot of money for dependable automatic controls. Like many manufacturers, you can use various Honeywell industrial controls as the efficient, low-cost means of automating your equipment . . . improving performance . . . increasing safety. And, you can use these inexpensive controls to save time, money and space by extending automation in your plant or process.

There are more than 9000 standard types of Honeywell controls to handle temperature, pressure, liquid level and humidity—for control, switching or safety functions. There are electric, electronic and pneumatic types.

Though they're low in cost, these controls are top-quality, reliable devices. If there's not already a standard control for your particular application, Honeywell can design and build one for you.

Your nearby Honeywell field engineer will be glad to discuss your control requirements. Call him today . . . he's as near as your phone.

MINNEAPOLIS-HONEYWELL, Wayne and Windrim Avenues, Philadelphia 44, Pa.

**Honeywell**

H HONEYWELL *First in Controls*

**STYLE 804**
**BRAIDED ASBESTOS, MONEL**
**Asbestos graphite**
**Carbonite plastic core**
**Temperatures to 800° F.**

**STYLE 806**
**GRAPHITE COATED**
Monel-inserted asbestos over
Carbonite plastic core
Temperatures to 1000° F.

**STYLE 807**
**NON-GRAPHITED**
Monel-inserted asbestos over
Carbonite plastic core
Temperatures to 1000° F.

**STYLE 809**
**GRAPHITE COATED**
Inconel-inserted asbestos over
Carbonite plastic core
Temperatures to 1250° F.

**STYLE 810**
**NON-GRAPHITED**
Inconel-inserted asbestos over
Carbonite plastic core
Temperatures to 1250° F.

***Look at the specs . . . and you will select***

# ANKORITE

## High Pressure, High Temperature PACKINGS

The Anchor Packing Company—with more than 50 years experience in the mechanical packing industry—specializes in *designing the packing for the application.* That is one reason why Anchor packings are always efficient, more effective and longer lasting.

Here's an example: Displayed in cross section are five ring and coil packings, all specially fabricated to give long service in high pressure, high temperature applications. Styles 806, 807, 809 and 810 are ideal in valve stems and expansion joints for superheated steam, hot gases and hot oils. Style 804 stays soft against high pressures and temperatures . . . is unsurpassed in control valves, throttle valves, autoclaves and similar services.

If you have a packing problem, see your local Anchor Representative. He will gladly assist you. Or, contact the Anchor General Office. Write for our new catalog.

**DISTRICT OFFICES**

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| BUFFALO, N.Y. | CLEVELAND, OHIO | MINNEAPOLIS, MINN. | SEATTLE, WASH. |
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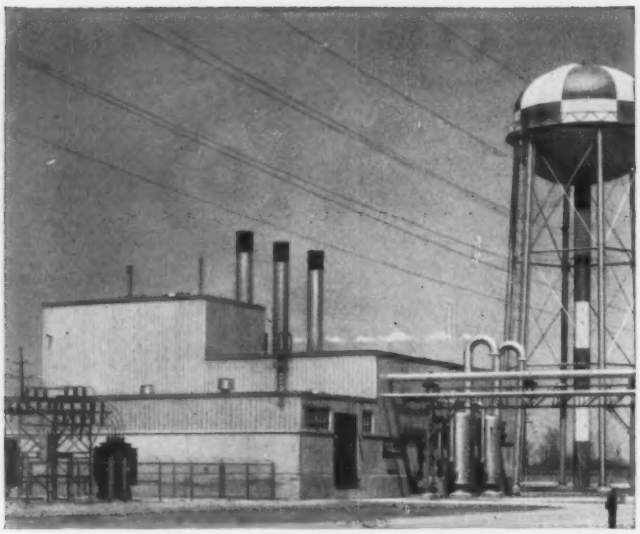
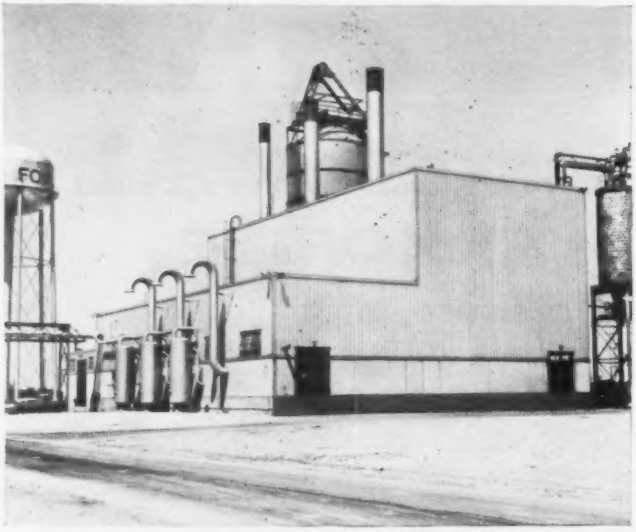
# THE ANCHOR PACKING COMPANY

GENERAL OFFICES . . . PHILADELPHIA, PENNSYLVANIA
FACTORIES MANHEIM, PA., ELKHART, IND., MONTREAL, CAN.

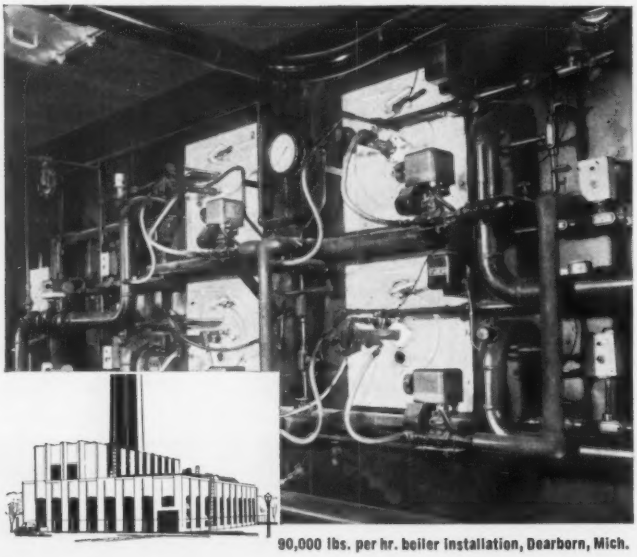
● FIBROUS AND METALLIC PACKINGS FOR EVERY INDUSTRIAL PURPOSE



Steam and compressed air plant, Rawsonville, Michigan. Total capacity: 120,000 lbs. per hr.



Steam and compressed air plant, Indianapolis. Total capacity: 300,000 lbs. per hr.



90,000 lbs. per hr. boiler installation, Dearborn, Mich.

# FORD POWERS UP with Pritchard-built power plants

What's the most important factor in an industrial power plant? Efficiency? Low investment cost?

The Ford Motor Co. will tell you it's neither factor—when considered separately. The highly efficient plant may have cost so much to build that its products—steam and air—are too expensive for the highly competitive automobile manufacturing business. On the other hand, the low cost plant may never operate efficiently and may be subject to frequent break-downs.

The first power plant built for Ford by J. F. Pritchard & Co. has shown a favorable operating cost-investment cost ratio. Since then, two more Ford power construction jobs have been completed by Pritchard.

Balancing investment costs with operating costs is basic to Pritchard's approach to power plant construction. This requires more than engineering skill alone—more than good construction—more than careful purchasing and coordination. It combines these factors in such a way that the completed plant costs least to own and operate in the long run.

If you are considering expansion or new construction, assign the job to Pritchard. Our services range from economic surveys to completion of turn-key jobs . . . our experience from the construction of industrial power plants to central stations.

INDUSTRY'S PARTNER FOR PROGRESS

J.F. Pritchard & Co.

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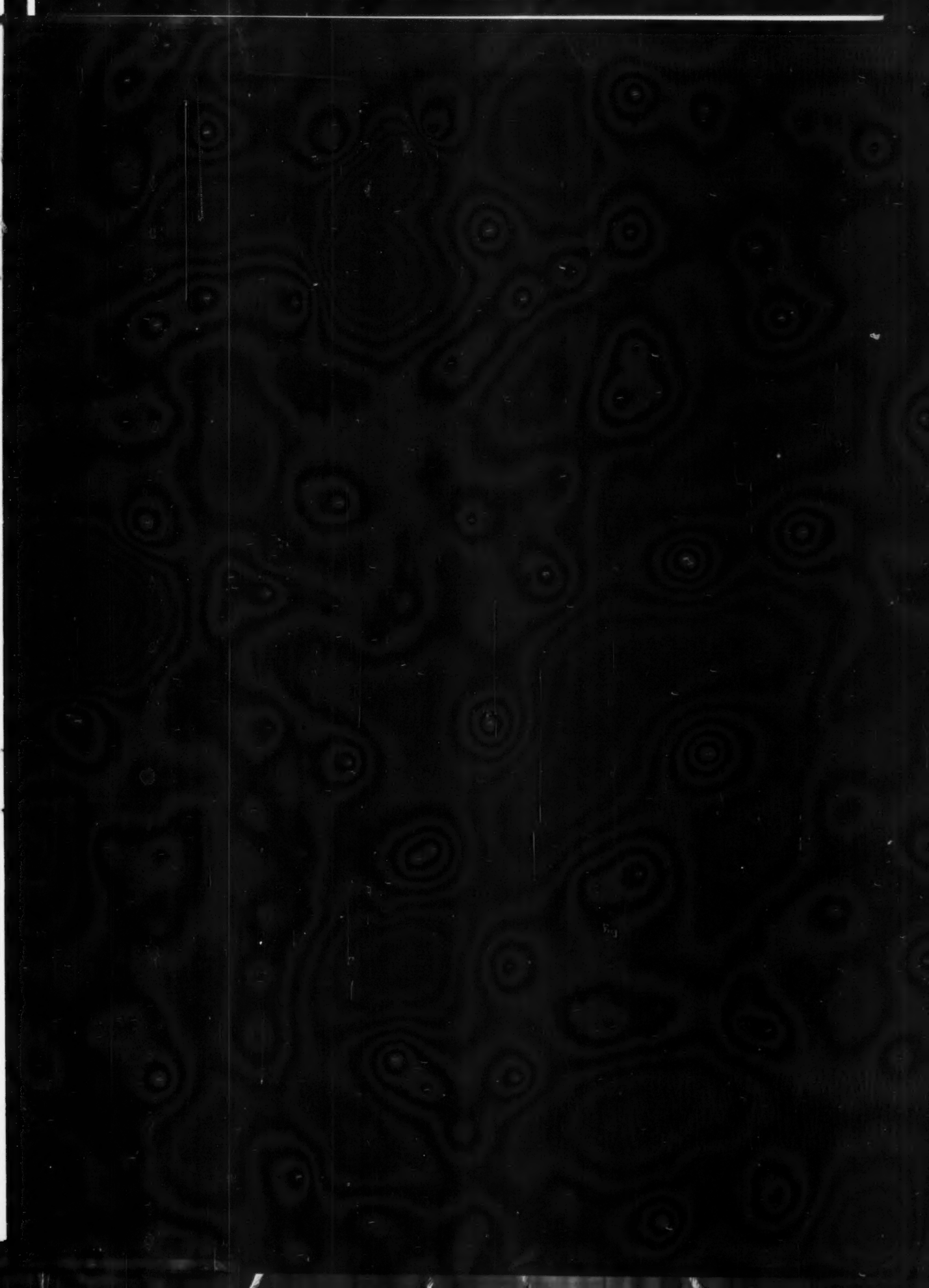
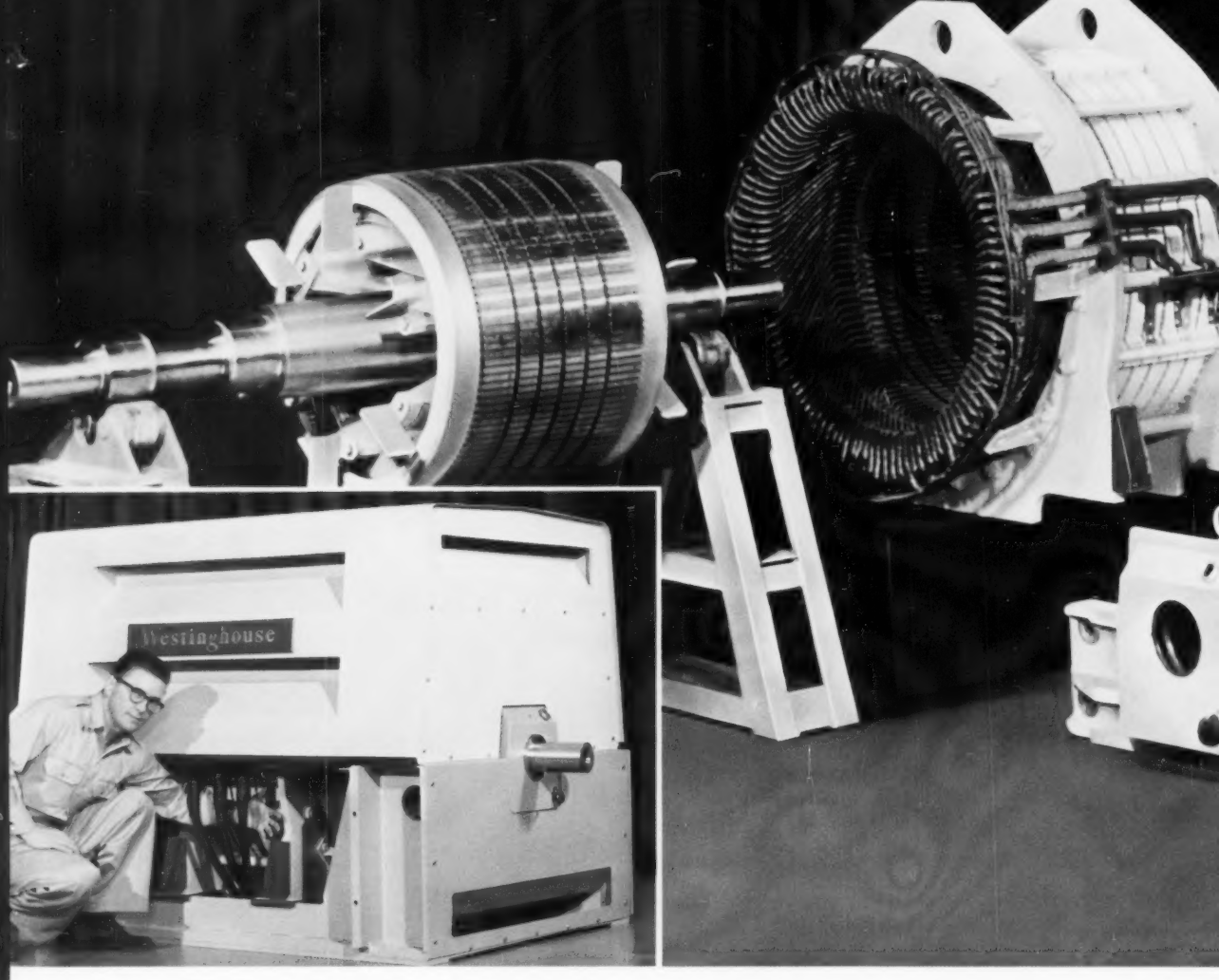
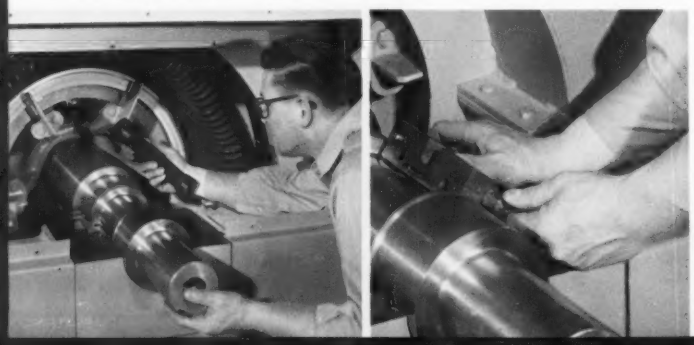





Protruding conduit boxes are gone. Cable comes through the base, leaving plenty of room for connecting motor leads.

By merely removing the end panels, you can see and inspect windings and bearing assemblies. Bearing assemblies come apart quickly for inspection. Remove bearing cap, top bearing shell and oil ring; then the bottom bearing shell rolls out for quick, easy bearing inspection.



## Top performance comb
## means greater motor v

The time-tested and-proved Westinghouse motor components which have always given you the best in dependable performance are now housed in completely removable enclosures. Advantages impossible in conventional motors are standard features of this modern-as-tomorrow FA Motor design.

- Now, when you specify an FA Motor, the outlines and dimensions are immediately available.
- Now, independence of housing from the stator enables you to make complete visual

## mbined with full accessibility
## r value

inspections of the windings.

• Isolation of stator from housing also makes the motor inherently quiet.

• Exclusive plunge-bored brackets permit precision alignment of bearings. Each time the motor is reassembled, these brackets precisely maintain alignment of the rotor.

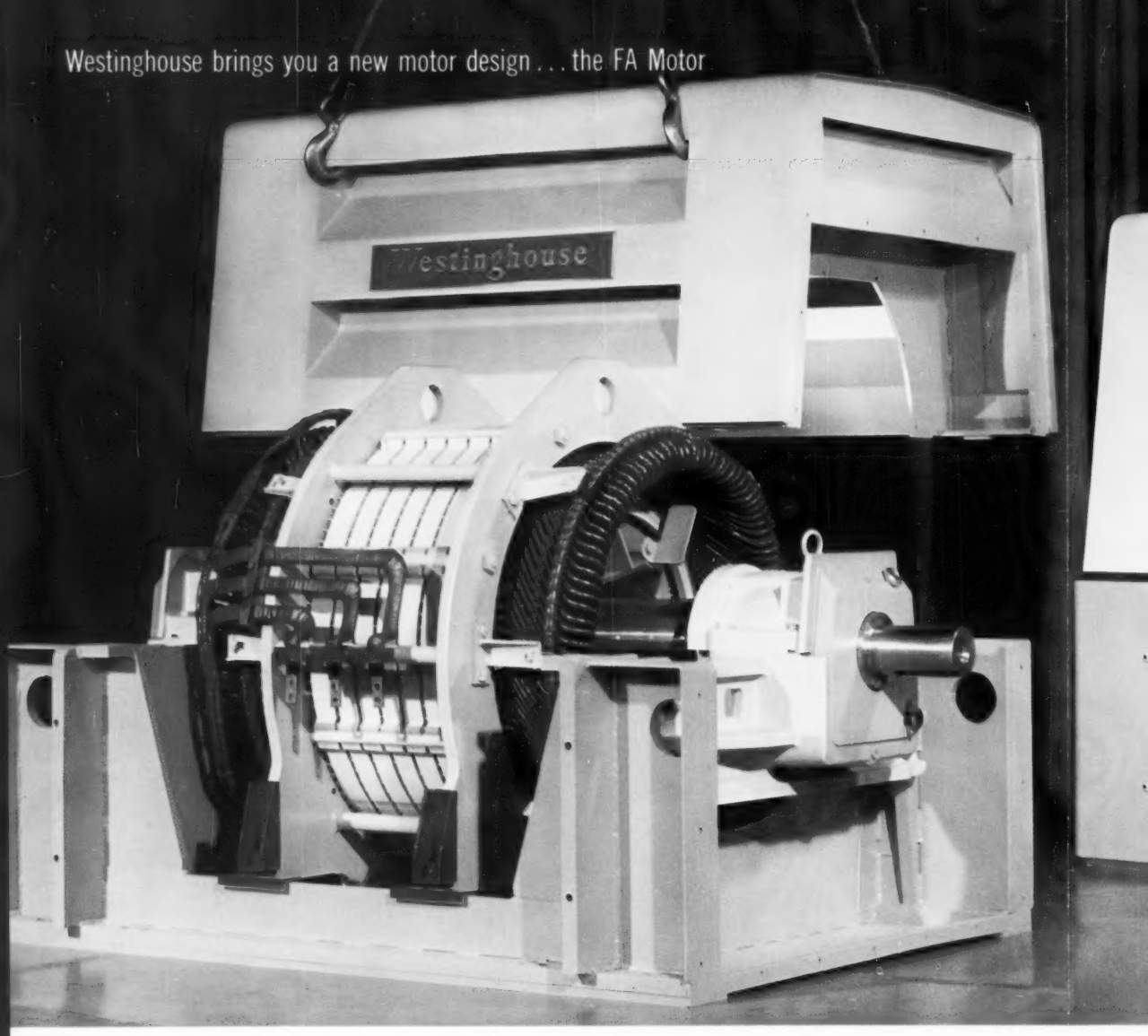
• Special locator joints simplify removal and replacement of the stator. By removing four bolts, the stator assembly is freed from the base. In reassembly, these ball-type joints automatically assure perfect realignment.

• Thermalastic® insulation, an exclusive feature in all Westinghouse large motors, adds further insurance that you're getting the very best in motor quality and performance. Since 1949, Thermalastic insulation has extended the service life of coils in large motors, generators and other large electrical rotating apparatus.

YOU CAN BE SURE...IF IT'S

Westinghouse

Westinghouse brings you a new motor design . . . the FA Motor




# revolutionary take-apart housing

## takes guesswork out of inspection

This modern motor concept combines the well-known reliability of Westinghouse large motors with a new and vitally important extra—*full accessibility!*

For the first time, the motor housing is completely separate from the stator, with all the benefits such construction implies. Inspection—once a matter of partial visibility and guesswork—is now an easy and thorough operation which insures your motor investment.

YOU CAN BE SURE...IF IT'S

Westinghouse

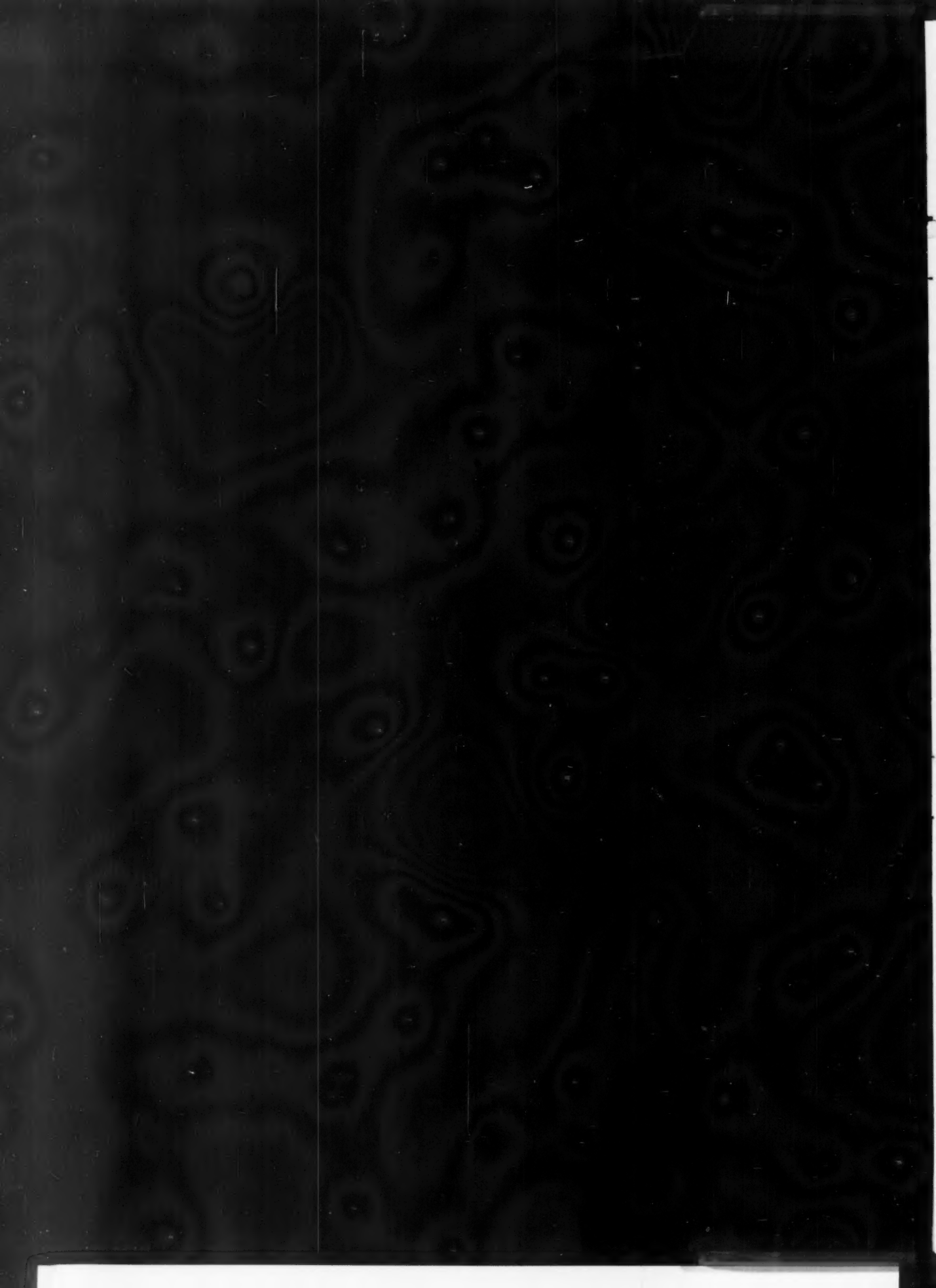
# The new Westinghouse FA Motor gives you five major advantages

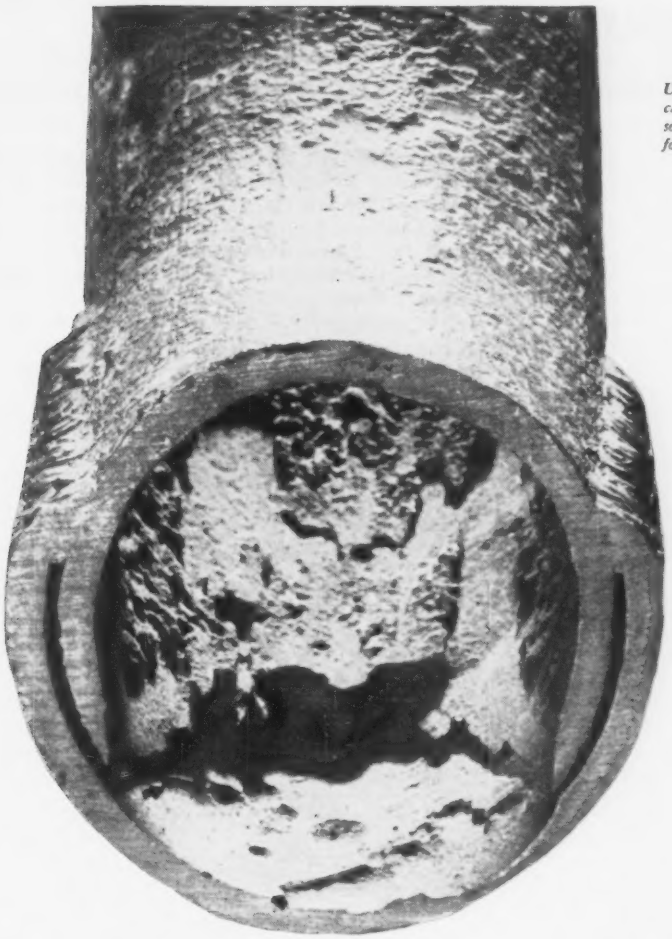
1. Full accessibility. Total inspection is possible for the first time. Enclosures are quickly removed, easily replaced. Reassembly is automatically precise.
2. Inherently quiet. Housing is isolated from the stator, reducing transmission of vibration and noise.
3. Thermalastic insulation. Recognized as the finest available, it assures long life and protection of coils.
4. The same basic components—rotor, stator and bearings—which have made Westinghouse motors famous for long, efficient service life.
5. Easy to connect. No conduit box. Cables pass through the base bottom with extra-ample room to connect motor leads.

These qualities make the FA Motor your best investment. It is available in ratings from 250 hp up to 7000 hp, depending on speed. For full information, call your Westinghouse representative, or write Westinghouse Electric Corporation, P.O. Box 868, Pittsburgh 30, Pennsylvania. JI-15005

YOU CAN BE SURE...IF IT'S

Westinghouse





*Unretouched photo of pipe, corroded by carbonic acid, which has been "half-soled." This was only a temporary cure, for now the patch is also being eaten away.*

## WHAT DO YOU PAY FOR "HALF-SOLED" PIPE?

Plenty—in expensive maintenance and costly down time. This pipe has been "half-soled" by welding a metal half-circle over the corroded section—a temporary measure at best. But the original cost has been lost, for now the patch is also being eaten away. You can save money by preventing damage like this with proper water treatment.

**A Consulting Service for You.** Whatever your water problem—analysis, testing or treatment procedures for boiler water, condensate, cooling towers, process waters—Dearborn has the engineers, the experience and the laboratory facilities to assist you in developing the program exactly suited to your needs. Your Dearborn Engineer will outline the many advantages a Dearborn Consulting Service Program will give you.

***WHY NOT CALL HIM IN...*** **MEANWHILE, MAIL THE COUPON FOR YOUR COPY OF THE DEARBORN CONSULTING SERVICE BOOKLET**

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**...a leader in water conditioning and corrosion control since 1887**

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*City*.....*Zone*.....*State*.....

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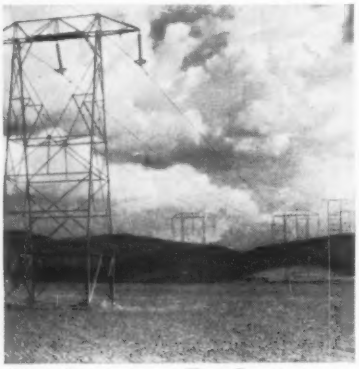
## ...a sound investment for increasing power requirements

### 15 Utility Companies Underwrite Study For Advanced Nuclear Power Reactor For the Southwest

Up from the Texas Panhandle... through the oil fields of Oklahoma... across the Kansas prairie... over the Ozarks of Arkansas and Missouri... and down through the rich bottom land of Mississippi and Louisiana stretches a vast network of electric power lines and generating stations. Through this vital system surges millions of kilowatts of power... lifeblood of the Southwest's cities, farms and factories.

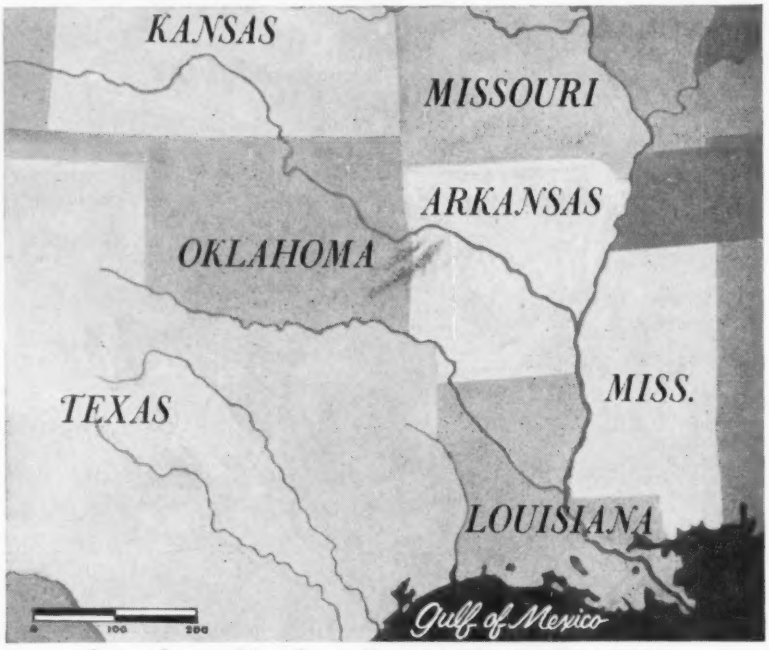
The bulk of this power (6,250,000 kw) is generated by fifteen investor-owned utility companies. Recently these firms made a decision that brings peaceful atomic energy into an important new phase.

**Planning together** as the Southwest Atomic Energy Associates, they signed a multi-million dollar contract with Atomics International to develop an advanced reactor concept for full-scale atomic-electric power stations. The new project is called AETR (for Advanced Epithermal Thorium Reactor). It promises to be economically competitive with power plants that depend on diminishing, increasingly expensive conventional fuels. Studies will be directed toward the design of a nuclear power plant of 200,000 electrical kilowatts.



NEW POWER FOR THE SOUTHWEST
Fifteen companies pool resources to develop an advanced power reactor

Interest in the project is indicated by a roster of the new group's member companies: Arkansas Power and Light Co., Arkansas-Missouri Power Co., Central Louisiana Electric Co., Inc., Empire District Electric Co. (Mo.), Gulf States Utilities Co., Kansas Gas and Electric Co., Kansas Power and Light Co., Louisiana Power and Light Co., Mississippi Power and Light Co., Missouri Public Service Co., New Orleans Public Service, Inc., Oklahoma Gas and Electric Co., Public Service Co. of Oklahoma, Southwestern Gas and Electric Co. (La.), and Western Light and Telephone Co., Inc. (Mo.).




SEVEN STATES MAP OUT A PLAN FOR ATOMIC ELECTRICITY

**Hardware in Action.** AI has built and is now operating two other nuclear power reactors as part of the AEC's program for economical power from atomic energy. One of these is the Sodium Reactor Experiment (SRE) which is supplying nuclear heat to operate an experimental electric power plant installed by the Southern California Edison Co. The SRE is providing technical data and experience for the design of full scale electric stations, such as the 75,000 kw plant for Consumers Public Power District of Nebraska.

AI's Organic Moderated Reactor Experiment (OMRE) has been operating at the AEC's National Reactor Testing Station in Idaho Falls since last September. It has provided technical and economic information for the construction of OMR power plants now planned for the City of Piqua, Ohio, and large network installations under consideration for this country and abroad. Atomic propulsion systems for supertankers and merchant ships are another important OMR application.

In addition, Atomics International research reactors are helping to bring "Atoms for Peace" to the free world. These reactors are now operating in Japan, Germany, Denmark, and the United States. Another is under construction for Italy.

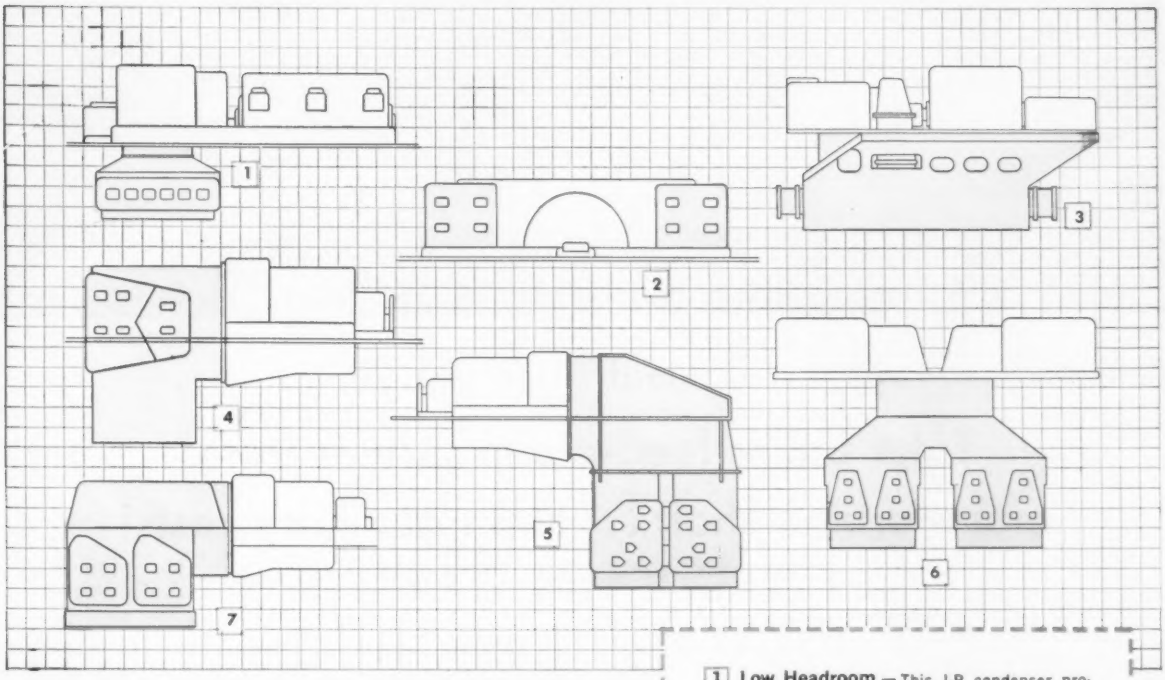
**Nuclear Power Abroad.** AI works with leading companies overseas. With DEMAG, one of West Germany's largest heavy manufacturers, AI has formed INTERATOM, a jointly owned subsidiary headquartered in Duisburg. AI has a technical assistance agreement with ASEA, a prominent Swedish electrical firm with offices in over 50 countries.

ATOMICS INTERNATIONAL, P.O. Box 309, Canoga Park, Calif. Cable Address: ATOMICS.

**ATOMICS INTERNATIONAL**
A DIVISION OF NORTH AMERICAN AVIATION, INC.
*PIONEERS IN THE CREATIVE USE OF THE ATOM*

# Look what Ingersoll-Rand is doing to surface condenser design

## to help power companies produce more kilowatts in less space and with better efficiency




1 **Low Headroom** — This I-R condenser provides 65,000 sq ft of surface in an under turbine area that allowed only 14′ 8″ of headroom.

2 **No Headroom** — This twin shell 110,000 sq ft condenser is integrated into the advanced design dual side-exhaust turbine.

3 **Integral Foundation** — The I-R condenser here serves as the foundation for the bottom-exhaust turbine and generator.

4 **Axial Exhaust Turbine** is served by this I-R condenser located at the turbine floor and direct connected for straight through steam flow.

5 **Low Syphon Head** was one of the requirements for this I-R condenser connected to the axial-exhaust turbine by a precisely engineered transition elbow.

6 **Independent operation** of either shell and reduced headroom result from this twin shell arrangement of a 212,000 sq ft I-R condenser.

7 **Compact, space saving** arrangement of a 110,000 sq ft condenser connected to an axial-exhaust turbine with steam flow to the condenser tube bundles located offset and below the turbine exhaust centerline.

EACH of the surface condenser designs shown above didn't "just happen." To the contrary, each one was deliberately and painstakingly engineered by Ingersoll-Rand after careful study and analysis of the customer's requirements. And because the basic rectangular design of I-R condensers permits varying the ratios of length, width and height over wide limits, a great variety of space requirements can be effectively met . . . turbine-condenser arrangements can be "tailored" for each installation. Furthermore, this is accomplished without departing from the fundamental proven *high-performance* principles such as controlled longitudinal distribution of steam with controlled flow areas and velocities . . . principles which Ingersoll-Rand originated and developed to increase condenser efficiencies.

These advantages help to make I-R condensers the most efficient available—readily adaptable to all steam plant requirements. And you'll find that I-R condensers are faster and easier to erect, too, because most of the welding is done at the Ingersoll-Rand factory under close quality control.

Let an Ingersoll-Rand Engineer tell you more about the advantages and the engineering that has made I-R condensers first choice with so many power companies. Ask him for your copy of Form 9300, New Horizons in Condenser Progress.

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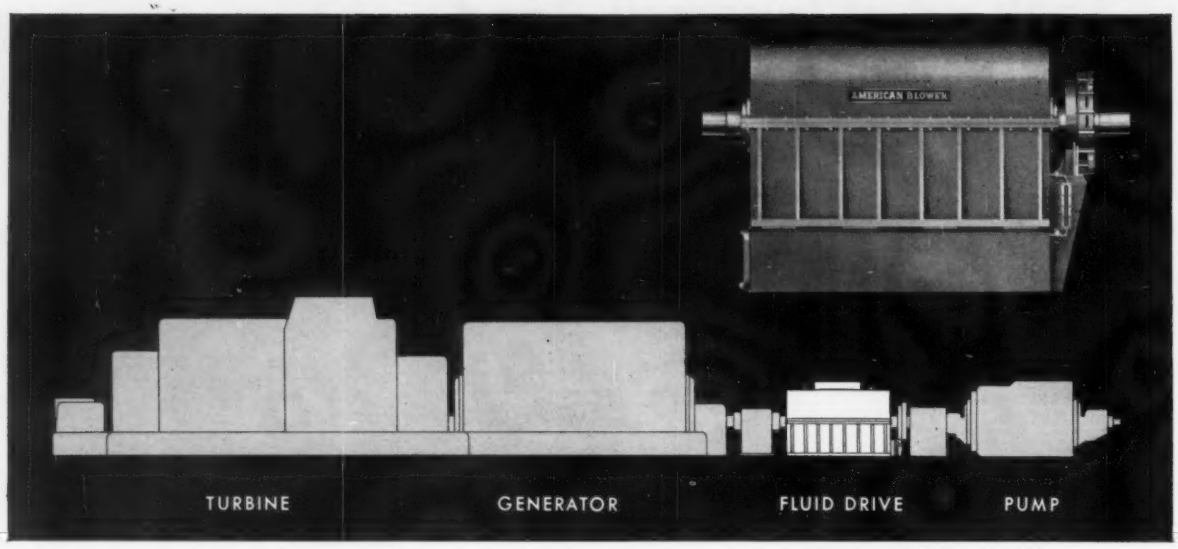
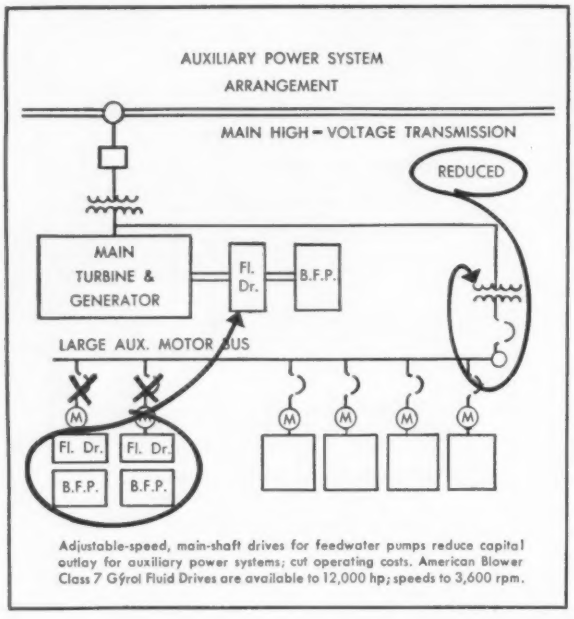
*There's no substitute for experience in engineered products*




American Blower *Gýrol*® Fluid Drive lets you:

# Take boiler feed-pump power from main-turbine shaft . . . slash auxiliary costs!

**Save price of motors, switchgear, conduit and cable. Release more power to consumer lines. Reduce operating costs.**




Adjustable-speed, main-shaft drives for feedwater pumps reduce capital outlay for auxiliary power systems; cut operating costs. American Blower Class 7 Gýrol Fluid Drives are available to 12,000 hp; speeds to 3,600 rpm.

Savings of nearly $500,000 are predicted for two new 290-Mw units scheduled for service this year. Both use main-turbine feedwater pumps driven through American Blower adjustable-speed Gýrol Fluid Drives.

Savings are threefold:

**1. Shaft-end pumps eliminate costly electrical accessories necessary for motor-driven feed pumps.**

**2. Auxiliary demands are reduced, so more power can be released to consumer lines.**

**3. American Blower Gýrol Fluid Drive saves power over the entire operating range. It offers adjustable-speed pump control that eliminates wasteful throttling; reduces wear by operating pumps at speeds to fit boiler demands.**

In addition, paralleling of pumps is simplified with Gýrol Fluid Drive. Emergency changeover from operating to standby pump is easily accomplished.

Let an American Blower sales engineer show you how Gýrol Fluid Drive can save power, cut costs . . . improve operating efficiency. Contact our nearest branch office, or write: American-Standard,* American Blower Division, Detroit 32, Michigan. In Canada: Canadian Sirocco products, Windsor, Ontario.

*American-Standard and Standard® are trademarks of American Radiator & Standard Sanitary Corporation.

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5 Cleaning Fabricated Piping
6 Built-up Weld, Metal Bosses
7 Welded Nozzles—Spacing
8 Preheat-Postheat Before, After Welding
9 Arc-Welding Dissimilar Ferritic Steels
10 Stress Relieving Practices

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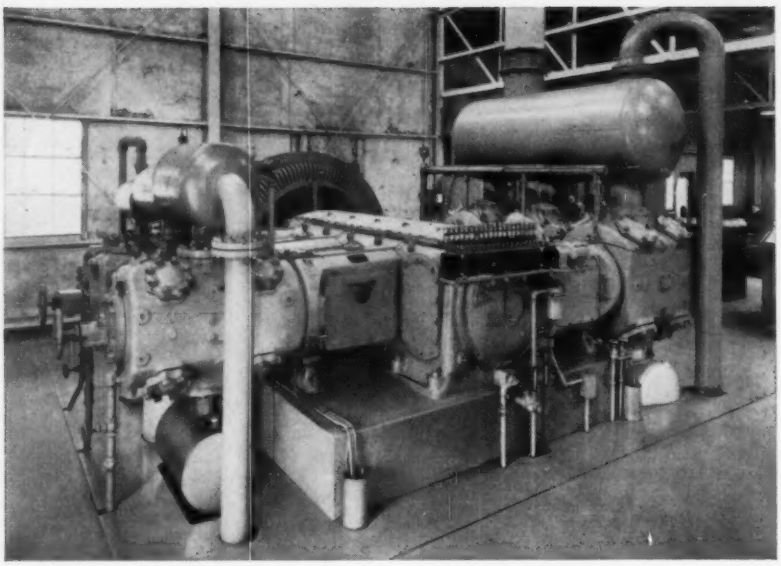
**Located in the Oakland,** *California plant of the Pacific Oxygen Company, this 5-stage Cooper-Bessemer FM, rated 800 hp at 300 rpm, handles the compression of air from atmosphere to 2250 psig.*



## at Pacific Oxygen...

*17,000 hour check proves continuous availability of*

**Cooper-Bessemer**

*compressor*

Operating as a 24-hour a day unit, this motor-driven Cooper-Bessemer FM compressor provides the dependability so necessary in the efficient production of liquid oxygen.

Recently, after 17,000 operational hours, an inspection of this 6-cylinder compressor revealed all parts in exceptionally good condition . . . proof of how Cooper-Bessemer delivers the type of performance that assures availability and eliminates costly "downtime".

For every air requirement in the 200 to 10,000 horsepower range, you will profit by remembering that Cooper-Bessemer answers the demand for heavy-duty, continuous operation at low cost. You can quickly obtain complete information by contacting the Cooper-Bessemer office nearest you.

**Write for your free** copy of the new 44-page Industrial Air Bulletin M-81. Address The Cooper-Bessemer Corporation, Mount Vernon, Ohio

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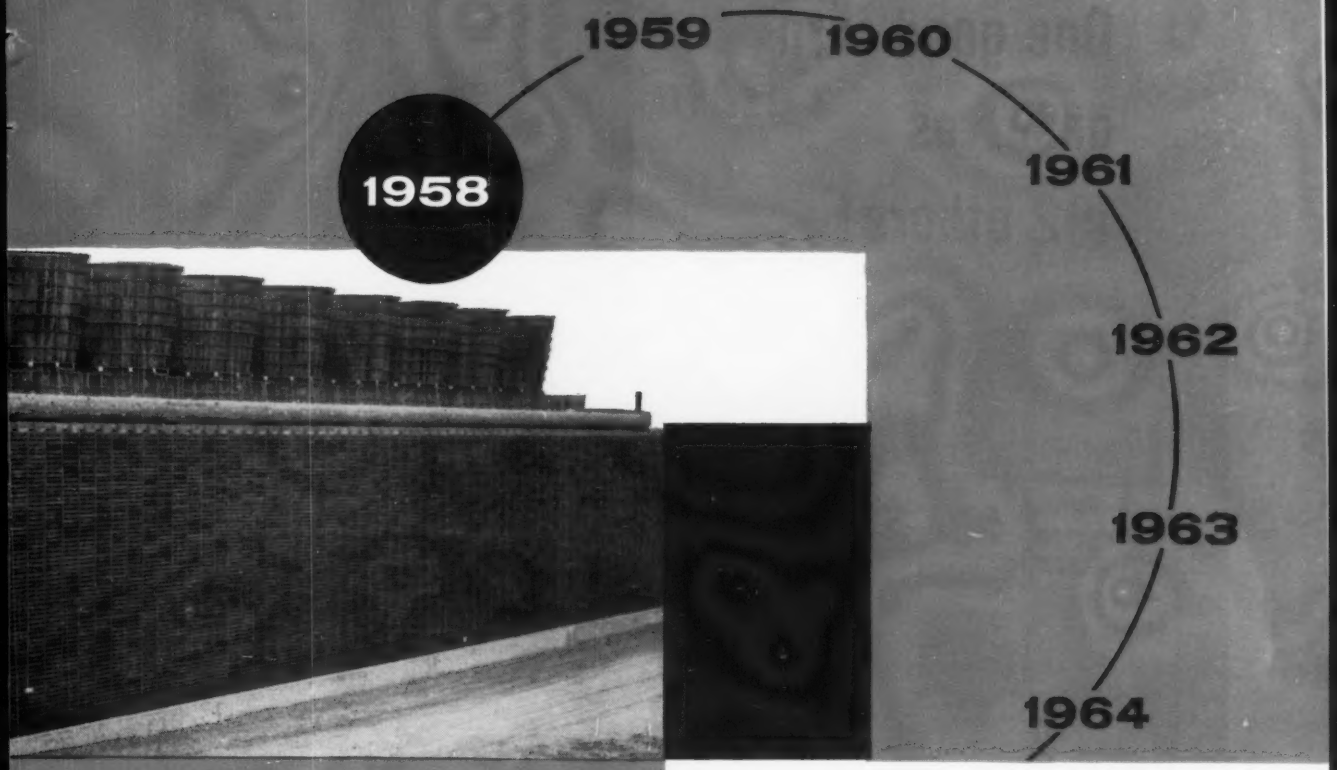
# protected from fungal decay

## now . . . and for years ahead




All of the 2,100,000 board feet of lumber used in constructing the mammoth Clinch River Station cooling towers of the Appalachian Power Company at Carbo, Va., was pressure-treated with Koppers chemical preservatives to protect it against the development of fungal decay, the most frequent cause of early tower failures. Koppers pressure-treatment was specified for this important installation, because Koppers methods and preservatives assure tower lumber a maintenance-free life expectancy many times longer than that of untreated redwood.

As pioneers in the development and perfection of wood preservative chemicals and techniques, Koppers has successfully treated more cooling tower lumber than any other company in the United States. Koppers many years of scientific and technical experience are your positive assurance of the *best* in lumber protection.

For complete information, clip and mail the coupon today. No obligation.

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Pittsburgh 19, Pa.

Send me complete information on the use of pressure-treated lumber in cooling tower construction.

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Company_____

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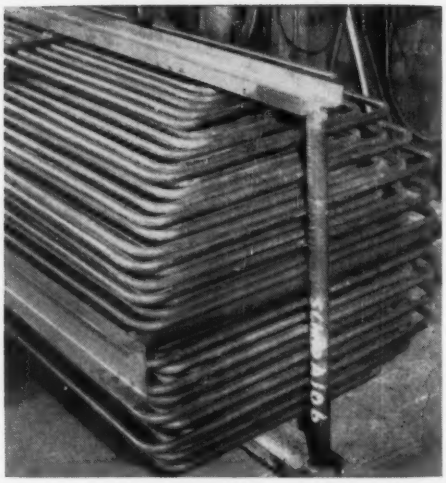
# One good turn deserves 192 others!



Pipe fabricators: Cornell & Underhill, Inc., Hoboken, N. J.

**During fabrication,** the USS* NATIONAL Seamless Steel Tubes used in this 8-ton heat exchanger were turned, or bent, 193 times! What's more, fabrication involved 584 pipe welds of various types and 1,720 inches of fillet welding. Mainly, the 35-foot-long, 5-foot-high bundle consists of ¾-inch Schedule 80 NATIONAL* Seamless Pressure Tubes; fabricated for the Solvay Process Division of Allied Chemical & Dye Corporation.

NATIONAL Seamless Pipe and Tubes are known the world over for safety and dependability. They are available in carbon through the various alloy and stainless grades. Get the complete story by sending for Bulletins 10 and 26. And, for technical assistance, our Mill Service Force is available for field consultation. Write to National Tube Division, United States Steel, 525 William Penn Place, Pittsburgh 30, Pa.

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**National Tube Division of USS United States Steel**

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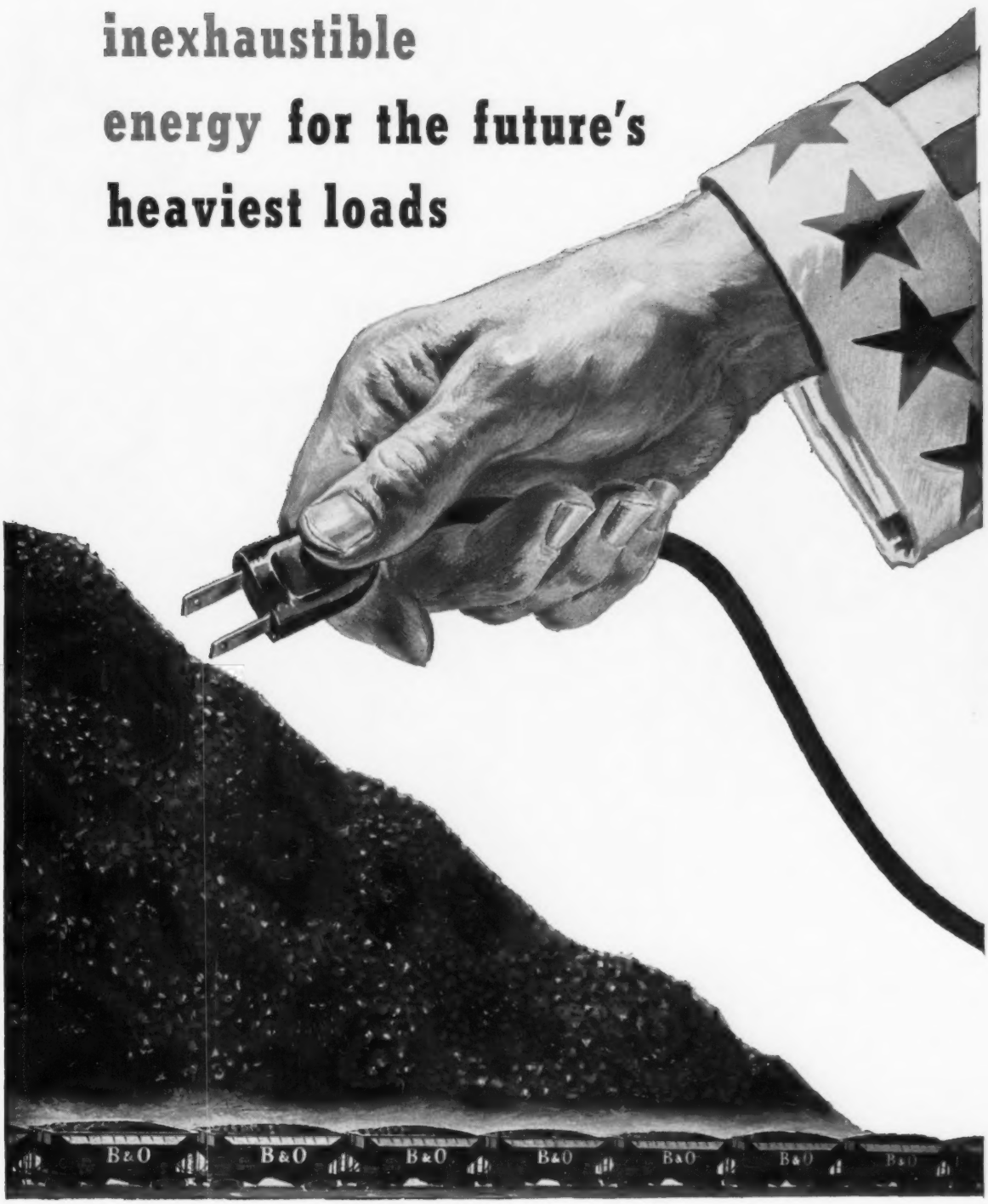
# inexhaustible energy for the future's heaviest loads

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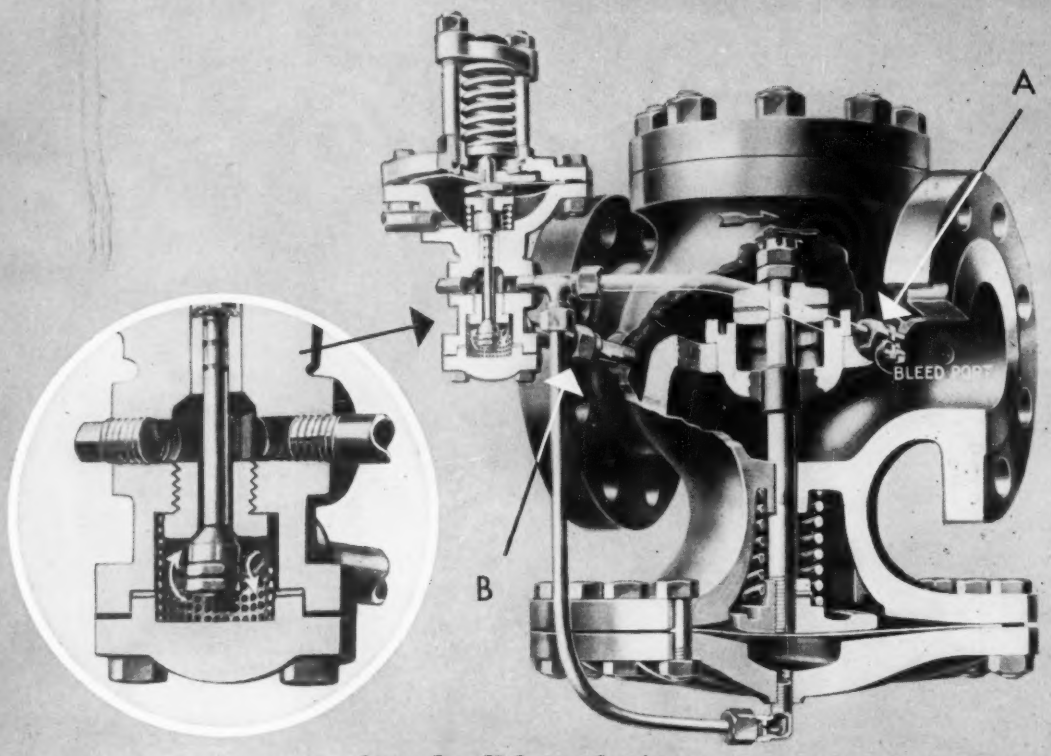
**VALVE TIPS:**

# *Advantages of External Pilots in Automatic Regulating Valves*




Spence Type ED Pressure Regulator

"Maintenance-free, trouble-free, install-and-forget." They're all pretty phrases, but every engineer knows from experience they don't apply to regulating valves. Any valve designed to control temperatures or pressures within tight limits can be affected by dirt or other foreign matter in steam lines.

One advantage of the external pilot mounting shown above is simplified maintenance. Trouble shooting is faster, downtime is reduced, and tempers don't take such a beating. Here's why:

If trouble develops, it's easy to find out if it's in the pilot or the main valve. Just remove the tubing bend at A. A simple test, without any instruments or other equipment, shows where the trouble is.

If the trouble is in the pilot, you can remove it by disconnecting the unions at B. There's no need to take the main valve out of the line.

The quickest way to get the regulator functioning again is to install a spare pilot. This is easy — and in the Spence design it's not expensive to carry spare pilots. Spence pilots fit all sizes of Spence main valves. There's no need to stock an expensive inventory of pilots for each main valve size.

In the enlarged sectional drawing above, you can see how the strainer, seat and disc of the pilot are readily accessible by removing the blind flange.

If the trouble is in the main valve, here again inspection is easy. If there's dirt in the steam line, it may clog the bleed port or restriction orifices. In the Spence design these can be inspected and cleaned by merely removing the tubing connections. The seat and disc of the main valve can also be inspected easily by removing the top flange.

These maintenance advantages, plus other advanced design features, are available for a wide range of regulating applications. For information on Spence's wide range of different automatic regulating valves, write for your copy of Bulletin 1005.

**SPENCE ENGINEERING COMPANY, INC.**
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**ALCOA ALUMINUM CONDUIT OFFERS NEW ECONOMY FOR ELECTRICAL DISTRIBUTION SYSTEMS.** A growing number of consulting engineers, architects and contractors are recommending Alcoa® Aluminum Electrical Rigid Conduit as the ideal way to save electrical distribution dollars and to insure complete dependability. For distribution systems in office buildings, factories, refineries, processing and chemical plants and other new and remodeled structures, corrosion-resistant aluminum conduit has always offered a tremendous bonus in attractive appearance, longer life and maintenance-free operation. Now, lower prices in all sizes have made aluminum competitive with other materials. Aluminum conduit is easier to cut, bend and thread; it is nonstaining without painting; it is nonmagnetic and reduces voltage drop up to 20 per cent. It is nonsparking, lighter in weight and easier to install. It has the approval of Underwriters' Laboratories, Inc. Available for immediate delivery. For more information, contact your nearest Alcoa conduit distributor or Alcoa sales office. Aluminum Company of America, 2322-G Alcoa Building, Pittsburgh 19, Penna.

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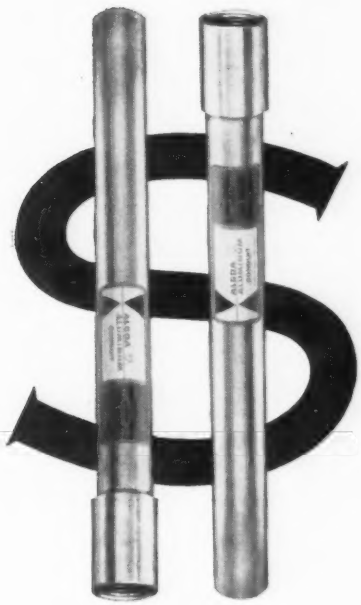


# *Now* "PACKAGED" AUTOMATION of Valve Operation, with LimiTorque

**Minimize use of these costly components!**

- Separate push button stations
- Separate reversing controllers
- Control racks
- Conduit runs, conduits
- Enclosures, piping, wiring
- Labor required for above items

## Saves 50% on Equipment & Installation costs

Once again LimiTorque is first . . . LimiTorque valve operators now offer integral mounted NEMA rated reversing controllers, push button and indicating light elements. You can actually reduce the installation and component equipment costs up to 50%.

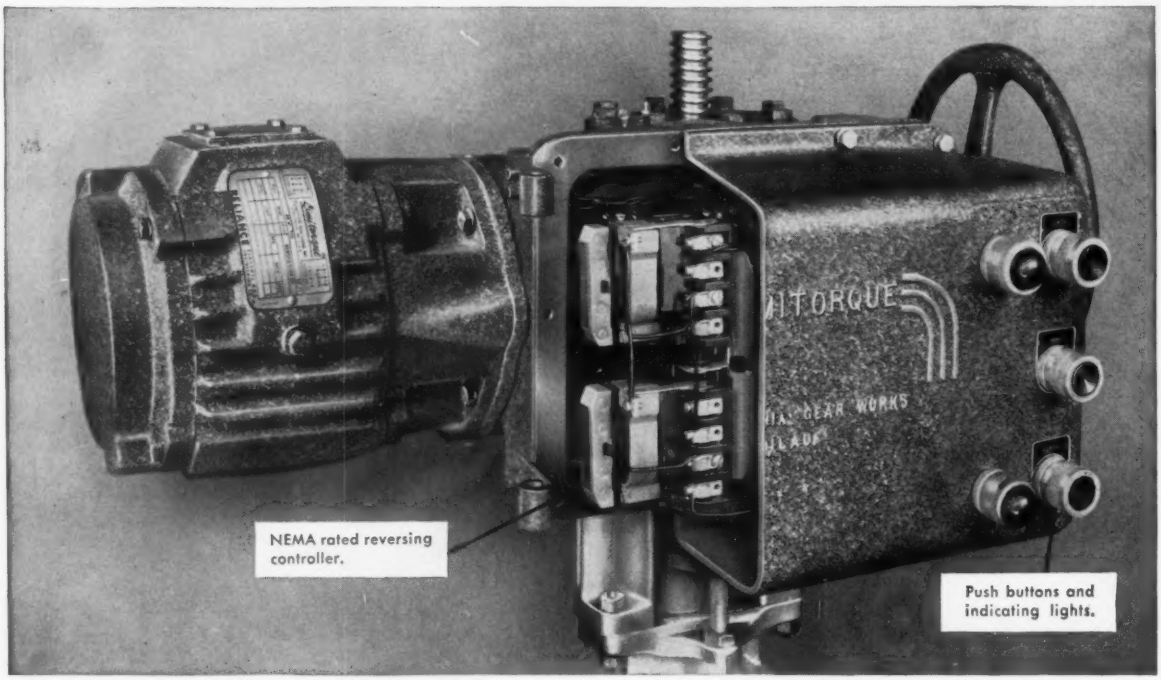
Various combinations of control items can be included in the same switch compartment. Eliminate costly separate control components when they are obtainable completely wired in your LimiTorque.

To compensate for temperature ranges, overloads are adjustable from 85% to 115% of the heater rating.

Push button elements, selector switches, etc., when required, are mounted in the hinged cover for quick, easy accessibility to all control components. LimiTorque can be field mounted on your existing valves. Contact your valve manufacturer or closest LimiTorque sales engineering office.

Remember, today's trend is toward low cost simplicity. LimiTorque operators with integral controls are designed with this in mind.

*Write for further information.*

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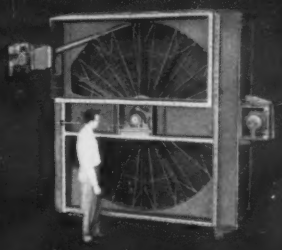
*Here's what you can do about the high cost of fuel.*



*Get the same heat from cheaper fuel with a*

# LJUNGSTROM® PACKAGE AIR PREHEATER

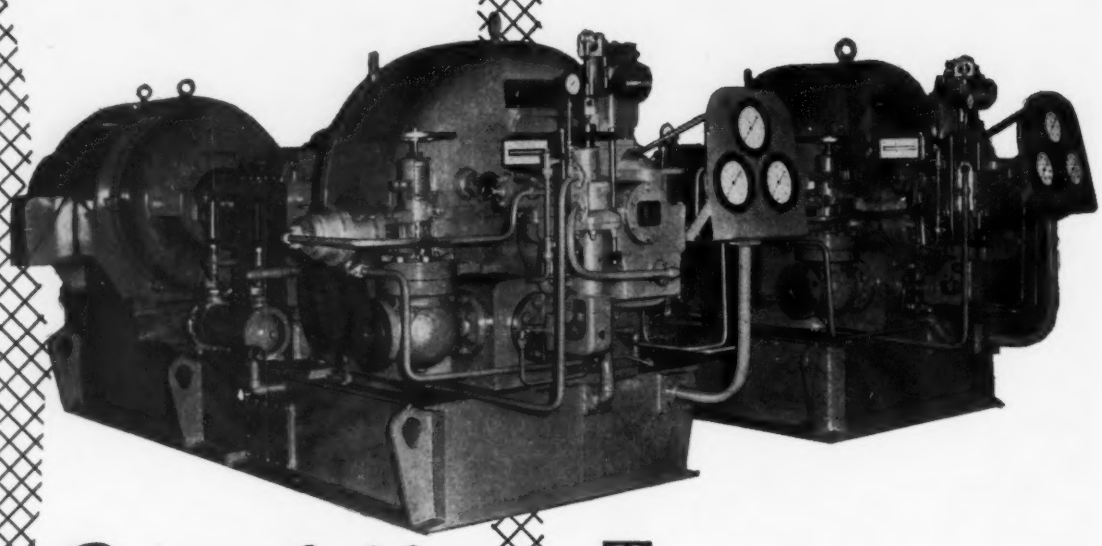
You can get standard operating temperatures from the cheaper fuels if combustion temperature is high enough. Peat, bagasse or even wood can be used successfully. The Ljungstrom Air Preheater can increase combustion temperature by as much as 300° by recovering heat from the exhaust gas. This reclaimed heat would otherwise go up the stack. All it costs is the price of the preheater—and the Ljungstrom can save enough on fuel to pay for itself in approximately two years.

You can be sure of maximum heat recovery because the Ljungstrom's exclusive rotary heat transfer element picks up the heat from the exhaust and puts it back into the combustion air without passing it through partitions or tube walls. Package design gives you all the advantages and economies of the Ljungstrom in a compact, preassembled unit. The Package Ljungstrom is available in vertical or horizontal models that are readily adaptable to any plant arrangement.

For further information, write today for the free 14-page Package Ljungstrom manual.

## THE AIR PREHEATER CORPORATION

*60 East 42nd Street, New York 17, N. Y.*



# Dependable LOW COST Power PACKAGE FOR THE SMALL PLANT

This pair of 200 KW Murray Turbine generators supply constant, around-the-clock electrical power in a mid-western plant.

The Murray Design 75 — 400 KW Turbine generator sets provide all the safety and economy features of the most modern larger designs — and at the same time offer the advantage of low initial cost and maintenance.

Murray Turbine generator sets can also be furnished in ratings from 500 KW to 3,000 KW. Your Murray Representative will give you details. Write for his name today.

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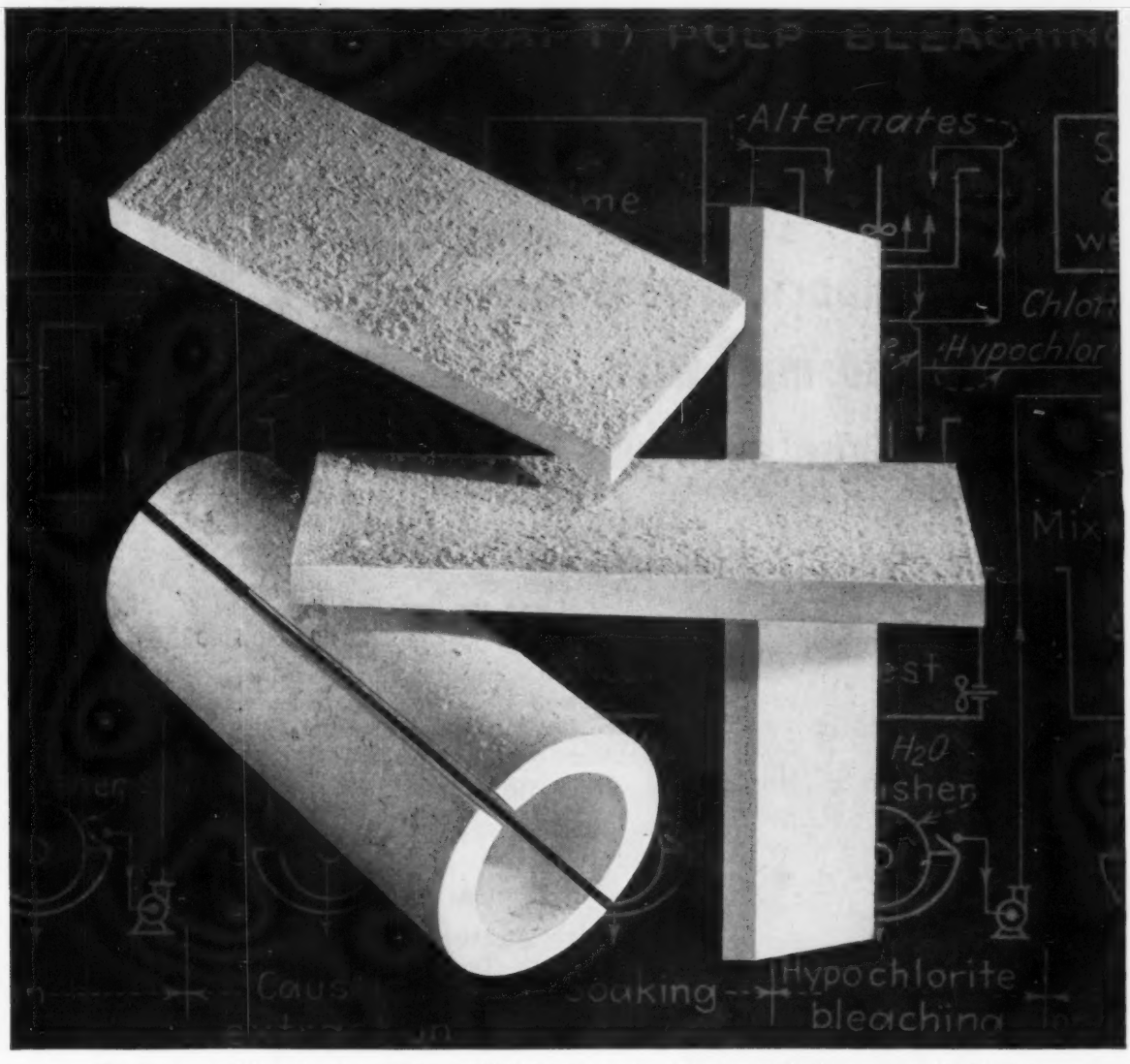
**Builders of Steam Power Equipment for Nearly a Century**




For paper pulp refining as in other operations, "K&M" High-Pressure Insulations provide durable, economical heat control.

# Your customers get more heat from every ounce of fuel with "K&M" High-Pressure Insulations!

Minimize installation time and costs, and be sure of customer satisfaction. How? With "K&M" High-Pressure Insulations.

Maximum fuel efficiency, minimum fuel costs, and more precise process control—that's what you offer your customers with "K&M" High-Pressure Insulations. They last the lifetime of the equipment. Tame temperatures of up to 1900° F. Withstand temperature changes, vibration, and moisture.

The ease of handling and installing of "K&M" High-Pressure Insulations makes your job quicker and more profitable.

Write to us today for a free brochure on "K&M" High-Pressure Insulations.

**For temperatures up to 1900° F.,** use "K&M" Hy-Temp Combination—diatomaceous silica overlaid with "K&M" "Featherweight" 85% Magnesia. Staggered joints prevent heat loss from expansion-caused openings.

**For temperatures up to 1350° F.,** use "K&M" Kaytherm—hydrous calcium silicate bonded with asbestos fibers. Important for petroleum and power applications.

**For temperatures up to 600° F.,** use "K&M" "Featherweight" 85% Magnesia—a basic carbonate of magnesia mixed with asbestos fibers.

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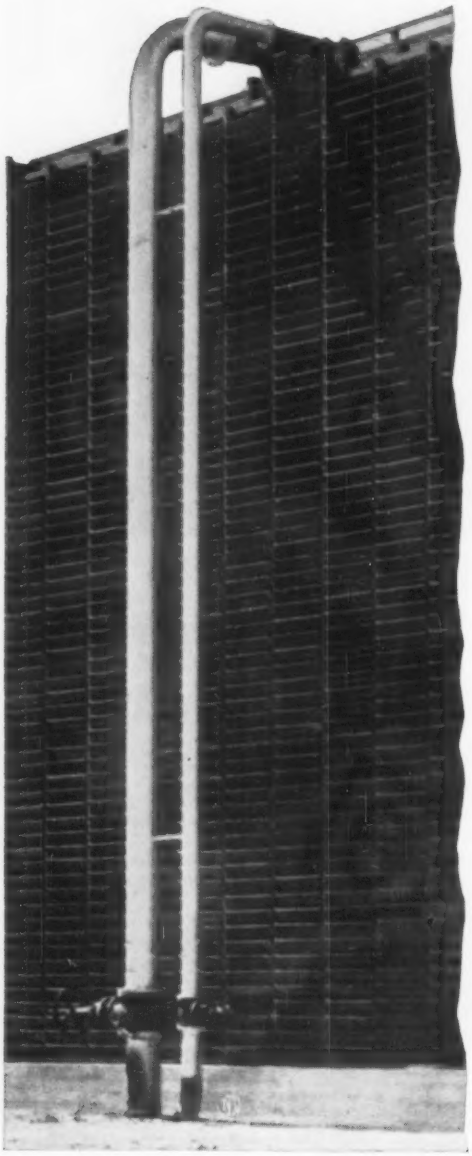
# An important message to men with algae problems



**Get safe, quick control with Allis-Chalmers No. 120 Series Algaecide**

This low-cost way to kill algae was introduced by Allis-Chalmers two years ago. It has proved an ideal solution to problems of plugged pump strainers, coated heat exchanger tubes and coated slats in cooling towers.

### Many Advantages

- **Safe** — Even in concentrated form it is only a mild irritant to skin and eyes.
- **Easy handling** — Pump, drip feed or manual feed can be used. No expensive feeders needed.
- **Non-oxidizing**
- **Corrosion inhibiting**
- **Service proved**
- **Economical** — Only 2 to 5 ppm required for effective dosage of most organisms.
- **Long lasting** — No loss of algaecide on passage through cooling tower.
- **Low toxicity** to fish or animals.

Number 120 Series Algaecide is toxic to more algae than any other algaecide. For complete information, call your nearby A-C office, or contact Allis-Chalmers, Power Equipment Division, Milwaukee 1, Wisconsin, for Bulletin 28X8434.

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LOUIS N ROWLEY, EDITOR • JULY 1958 • ESTABLISHED 1882 Power

# Don't sell the future short

IN A RECENT LETTER, Dr A G Christie, professor emeritus of mechanical engineering at Johns Hopkins, told me of an interesting find made during some office housecleaning. It was a folder containing manuscript copies of some of the many articles Dr Christie wrote for POWER during his long career as teacher and consultant. One of these articles, written about 1916, seemed particularly pertinent today. Its title was "The limiting size of steam turbine units."

Dr Christie started this article by referring to a discussion appearing in the Nov 25, 1913 issue in which it was concluded that 30,000 kw was about the limit of practical and economical size for turbine-generators. But, he pointed out, in 1916, less than three years later, units of 35,000 kw were in service, units of 40,000 kw were on order and consideration was being given to machines of 45,000 and 50,000 kw. What then might the future hold?

Looking ahead from 1916, Dr Christie saw clearly some of the problems to be overcome in designing still larger units, and what the answers would be. He saw how double-flow and compound construction could be used to keep physical size within limits. He pointed out the gains in efficiency and capacity that would result from higher pressures and temperatures, and the development in materials that would be needed to make these gains possible. And he analyzed clearly the conditions of power-system demand that would make ever larger units economically desirable.

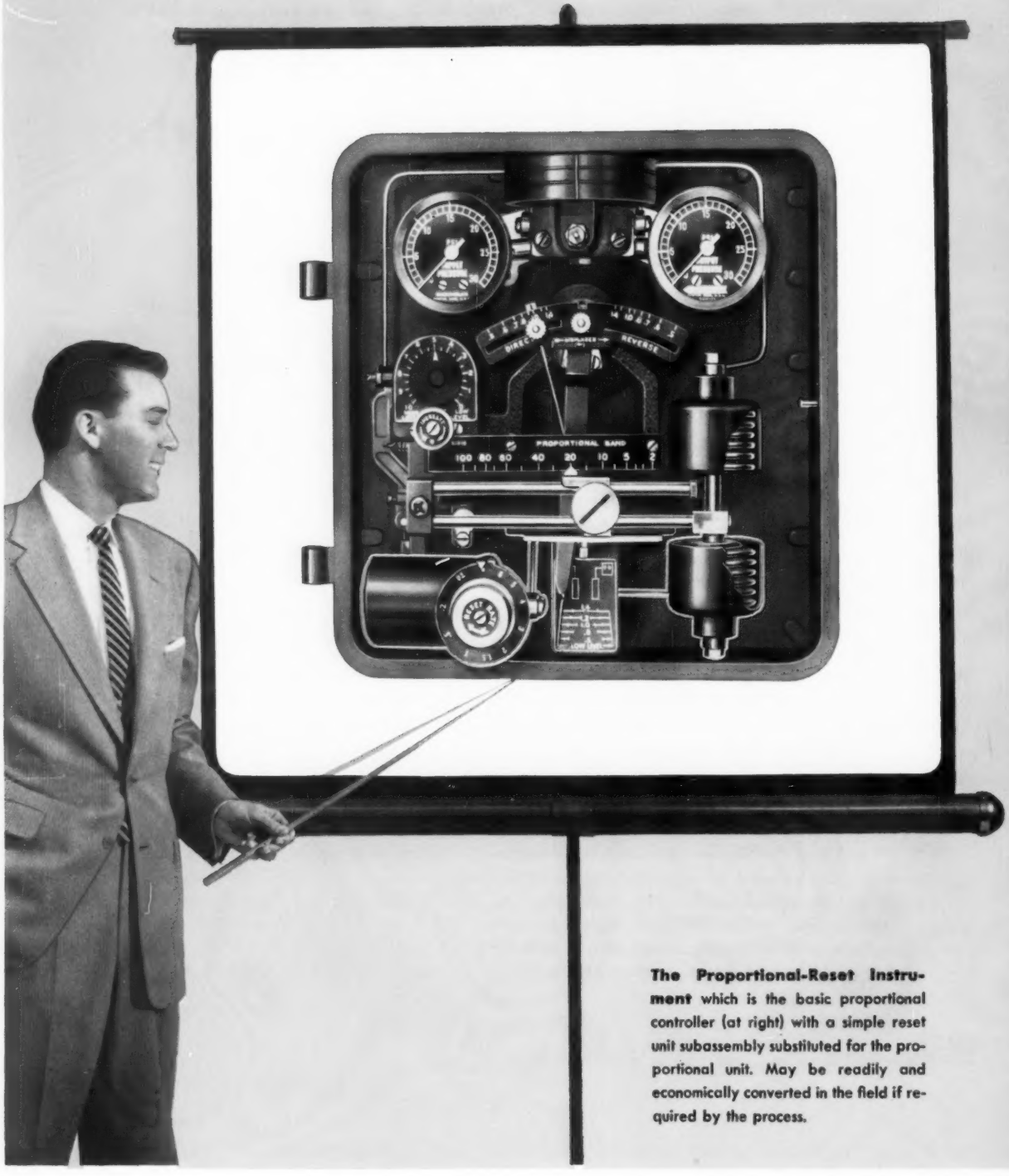
To many of the readers of this 1916 article his conclusions must have seemed visionary. Not only did he forecast the early commercial possibility of 100,000-kw units, but he said, in effect, that the only limit would lie in what the utility companies might demand.

Progress since 1916 has fully vindicated his judgment: 100,000-kw units went into service in the 1920's, while the largest units now on order are 500,000 kw in the U.S. and 550,000 in Great Britain.

Dr Christie's article of 1916 holds interest for us today as a reminder of the great strides made in the power industry. But for me, at least, it had another and more important value: It stressed again the need for us as engineers to view the future with courage.

At any given stage of progress, it is easy to see problems that make further progress difficult. Yet all experience tells us that limitations disappear, problems are solved and difficulties are surmounted. We can never afford to underestimate the effort that will be needed to move ahead to new and higher levels of performance—but, at the same time, we must never sell the future short.

# MASONEILAN LEVEL CONTROLLERS




**The Proportional-Reset Instrument** which is the basic proportional controller (at right) with a simple reset unit subassembly substituted for the proportional unit. May be readily and economically converted in the field if required by the process.

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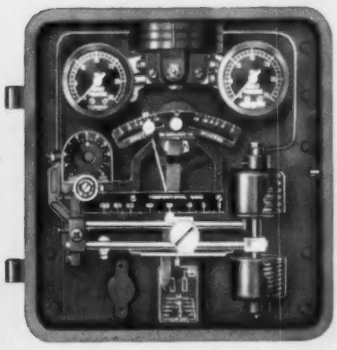

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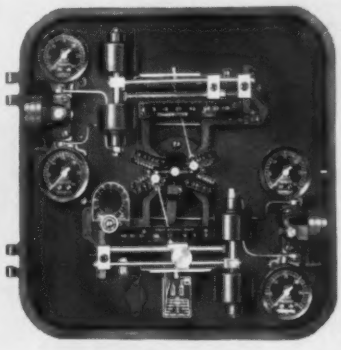

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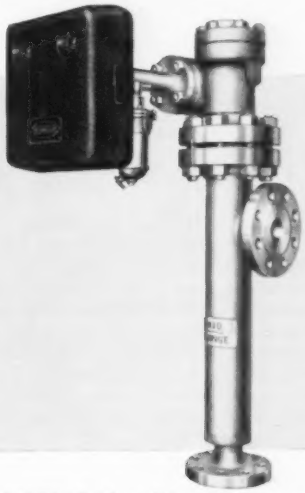
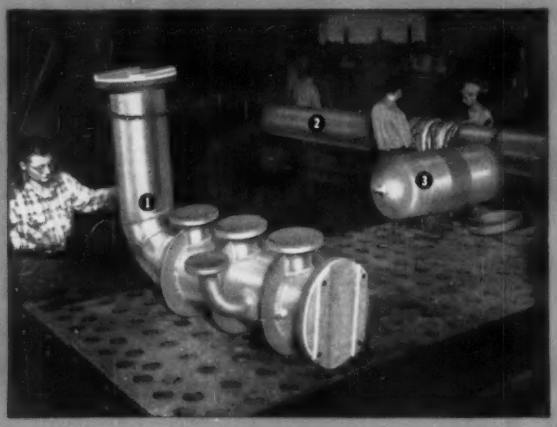


**12000 Series Controllers** are available in a wide variety of mountings and connections; level ranges; pressure and temperature ratings — types for all applications.

# ALL IN A DAY'S WORK at *Pittsburgh Piping*



These three jobs are typical of the wide variety of custom piping work which we do for the power and process industries. In the background of the photo welders are shown making the heli-arc root pass on 18" O.D., 3.875" wall, chrome-moly main steam piping. In the foreground, ready for final inspection, is a 12" header for a process operation, fabricated of ⅜" aluminum alloy. The pressure vessel, of austenitic steel, is one of many we produce for atomic energy application. The manufacturing of this type of piping requires specialized facilities . . . for engineering, fabricating, testing, assembly, and erection. We have those facilities. Use them on your piping jobs.

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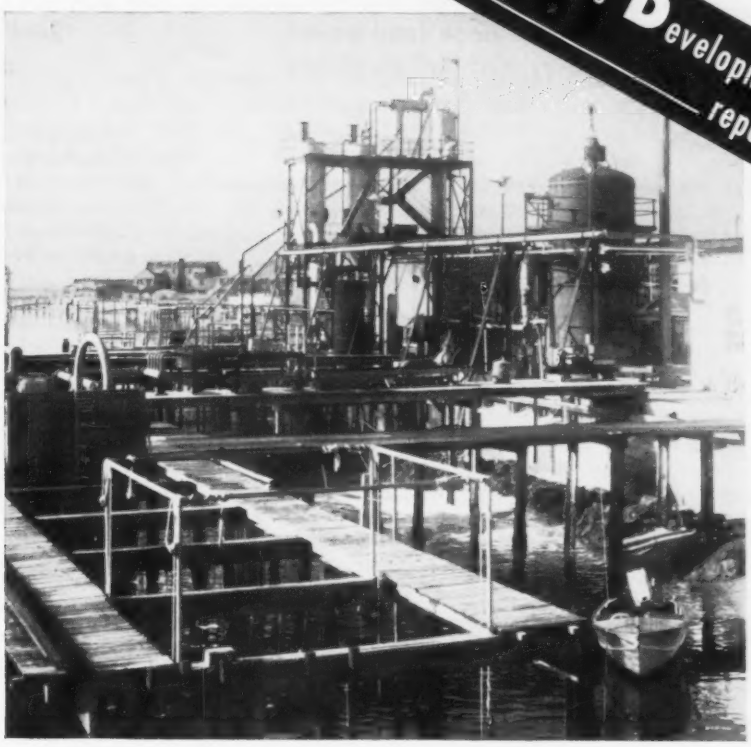
**Design and equipment application section**

B G A SKROTZKI
Associate Editor in Charge

a Today's Development report



**EXPERIMENTAL EVAPORATOR UNITS** on dock of International Nickel Company's testing station, Wrightsville Beach, N. C., demonstrate vigorous research program carried on by five manufacturers and research groups to find cheaper ways of desalting water

# Fresh water from the sea

**WHY?** To back up inland water sources in meeting a growing thirst and to compete with rising costs of hauling floods of water over ever-longer pipeline distances

**WHEN?** Now—in some special locations where industry and its people must work and live despite a water shortage. In one or two decades—where booming populations outgrow their wells and reservoirs. Never—in lush regions blessed with cyclical rains and stable populations

**HOW?** Distillation finds widest application today, but it must be improved by solving its special problems. Electrodialysis works in desalting brackish waters. Freezing, osmosis, immiscible liquids, ion exchange, precipitation and algae action are other possible methods under study Turn page

By B G A SKROTZKI
Associate Editor



◀——Perforated for your filing ease

## 1—Typical large land-based sea-water distillation plants

| Location | Total capacity, gpd | Type | Manufacturer |
|---|---|---|---|
| Kuwait, Persian Gulf | 2,500,000 | ST | Weir & Westinghouse |
| | 2,500,000 | F | Westinghouse |
| Aruba, Caribbean | 3,500,000 | ST | G & J Weir |
| Nassau, Bahamas | 1,200,000 | ST | G & J Weir |
| Curacao, Caribbean | 1,000,000 | ST | G & J Weir |
| Las Piedras, Venezuela | 450,000 | ST | Griscom-Russell |
| Mirafiori, Italy | 300,000 | ST | Escher Wyss |
| Marcus Hook, Pa. | 300,000 | ST | Westinghouse |
| Kindley AFB, Bermuda | 225,000 | VC | Cleaver-Brooks |
| Dharan AFB, Arabia | 200,000 | VC | Cleaver-Brooks |
| Gibraltar | 200,000 | F, VC | Cleaver-Brooks |
| PG&E, Morro Bay, Calif. | 150,000 | ST | Lummus Co |
| Buenos Aires, Argentina | 150,000 | ST | Escher Wyss |
| Thule AFB, Greenland | 130,000 | VC | Mechanical Equipment |
| Arrowhead & Puritas Co, Los Angeles, Calif. | 100,000 | VC | Cleaver-Brooks |
| Ecuador, South America | 100,000 | F | Cleaver-Brooks |

*AFB—Air force base*
*F—Flash evaporation*
*PG&E—Pacific Gas & Electric Co*
*ST—Submerged tube*
*VC—Vapor compression*

## 2—Estimated costs at plant of desalting methods

(Cents per 1000 gallons fresh water)

| | | |
|---|---|---|
| 1. | Long-tube vertical evaporators (1955 estimate) | 50 |
| 2. | Electrodialysis (4000 to 350 ppm reduction) | 80 |
| 3. | Vapor-compression rotary still | 96 |
| 4. | Low-temperature flash evaporation | 120 |
| 5. | Solvent extraction | 140 |
| 6. | Indirect freezing | 150 to 200 |
| | **Typical present delivered fresh-water costs:** | |
| a. | Agricultural irrigation | 12 |
| b. | Municipal service | 35 |
| c. | Industrial distilled water, maximum about | 300 |

## 3—Aims of evaporator research and development

| | | |
|---|---|---|
| 1. | Eliminate scaling | allows continuous operation |
| 2. | Eliminate corrosion | avoids costly tube replacement |
| 3. | Raise heat-transfer rate | reduces surface investment |
| 4. | Reduce energy input | lowers operating cost |

On the average, each of us uses about 60 gallons of fresh water per day for our personal comfort. But taking into account all the domestic, commercial and industrial services we need, our water demands mushroom to over 1500 gallons per day.

### Natural-water cycle

All this water originates by evaporating from the oceans. Low-rate vaporizing of sea water leaves behind contaminating salts and also cools the ocean. Solar radiation warms the ocean water to replace energy carried away by the vapor. This is the motivating factor that maintains the production of vapor.

The vapor is carried away by the wind and eventually cools to form water. It falls as rain or snow on the land to supply us with life-giving fresh water. After use, we let the water drain back to the ocean carrying with it wastes and salt that add to the ocean pollution. Ocean solids average about 35,000 ppm, drinking water less than 1000 ppm.

### Basic processes

This vast natural cycle has all the processes needed to get fresh water from the ocean: (1) heating for vaporization (2) separation of vapor and salt water (3) cooling of vapor to condense it to fresh water.

Most of our efforts to get fresh water from salt imitate this sequence. Many steamships and naval vessels have been doing this for years with their evaporator systems.

Where men must work in water-short areas adjacent to the ocean some large distillation plants have been erected. Some have run for over 20 years, see Table 1. In such places the crucial need for water relegates water costs to a secondary consideration. Literally, water must be obtained at any price. The problem boils down to choosing the most economical of known methods, realizing that cheap water availability in other parts of the world has no bearing.

### Desalting research

Our long-term growing population and industrial activity foreshadow critical water shortages in some U.S. areas in a matter of decades. Anticipating this problem, the 1952 Saline Water Act by Congress and a 1955 amendment gives the Secretary of the Interior authority to research and develop economical methods of desalting saline waters. He set up the Office of Saline Waters to do this job and Congress authorized a $10 million appropriation to complete the work by 1966.

### Desalting methods

One obvious effort was to improve on known vaporization methods. Scaling up industrial evaporators from the thousand gpd range to the millions needed for municipal supply helps to reduce unit water costs. But technical improvements can slash these costs further with benefit to the community economy. Table 3 lists the major objectives of evaporator development programs.

Table 4 lists most of the methods, theoretical and practical, that could be used to separate fresh water from salt water. All of these have been or are being researched by various laboratories and manufacturers, either with the support of the Office of Saline Waters (OSW) or privately.

### Desalting costs

Table 5 lists the energy sources or forms used to make a desalting system work. The availability, form and

## 4—Methods of desalting sea water

I. Physical processes
  1. Vaporization
    A. Solar evaporation
    B. Boiling
      a. Single effect
      b. Multiple effect
    C. Supercritical separation
    D. Flashing evaporation
    E. Vapor compression
  2. Crystallization
    A. Freezer-evaporation cycle
    B. Zone freezing
  3. Osmosis
    A. Synthetic membranes
    B. Molecular oil films
    C. Biological membranes
    D. Fiber membranes
  4. Immiscible liquids

II. Chemical processes
  1. Ion-exchange resins
  2. Precipitation

III. Electrical processes
  1. Ion-transfer membranes

## 5—Energy sources and forms for desalting sea water

1. Solar radiations
2. Fossil fuels
3. Shaft work
4. Waste heat (steam, hot water)
5. Electricity
6. Geothermal
7. Nuclear reactions

cost of the energy has a large effect on the overall water-production cost. Table 2 lists the costs of some of these methods and compares them with present water-supply costs. The newer methods don't seem to involve too heavy a cost penalty and they offer hope for future reductions.

To compare these methods the OSW uses these standard cost bases:

Amortization of capital investment at 5%
Interest charges at 3%
Fuel at 50c per million Btu.
Labor at $2.50 per man-hour.
Maintenance at 3% of investment
Insurance at 1% of investment
Power at 5 mills per kwhr
Steam at 55c per 1000 lb

The costs in Table 2 do not necessarily include all those that must be met in a practical working plant. Offices, housing, storage facilities, intake and discharge works, and other ancillary structures may easily double the total plant cost compared to the basic desalting equipment cost.

### Evaporating plants

Fig. 1 shows schematically the main elements of a submerged-tube evaporator plant, using processes and equipment that have become established during many years of application. Using live steam for evaporators proves costly—if we can use exhaust steam from backpressure or bleed turbines we achieve important overall fuel savings. Steam from waste heat boilers may prove economical under some conditions.

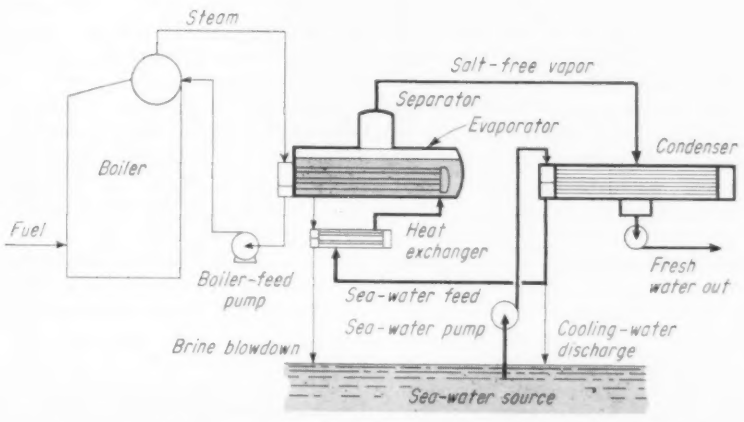
In conventional evaporators we have heat-transfer rates averaging about 400 to 500 Btu per hr per sq ft under favorable conditions. Any improvement in this factor means a proportionate decrease in heat-transfer surface with a saving in plant investment.

As evaporation continues, scale builds up on the evaporator tubes. This reduces vapor output to the point that the evaporator must be taken out of service and the scale removed. Usually this can be done by "cracking," which involves chilling the hot scaled tubes with cold water. In most designs, scale cracking is aided by the tubes bending under the thermal shock. Flushing out the evaporator shell removes the cracked scale so the unit can be put back in service.

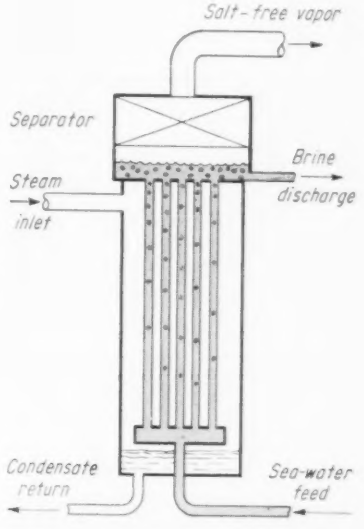
If scale build-up can be eliminated, evaporators can run continuously without reduction in heat transfer. Several efforts in this direction are trying to make water solids agglomerate on particles in the water instead of on heat-transfer surfaces. These particles or "seeds" are injected in the form of a sludge or slurry. Reports are encouraging.

### LTV evaporator

Fig. 2 shows long-tube vertical evaporator (LTV) used widely in the

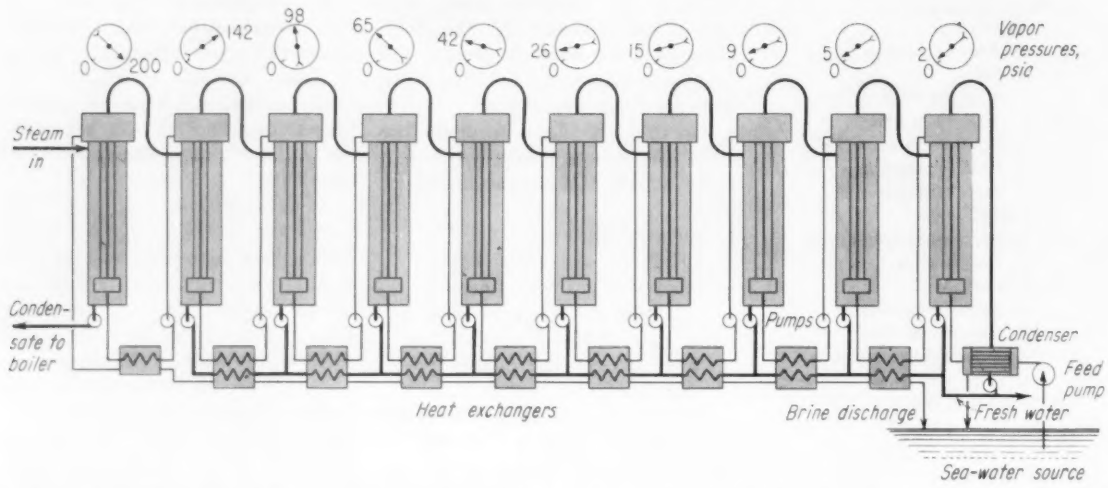



1 Conventional isolated sea-water distillation plant needs a boiler to produce steam, submerged-tube evaporator and condenser to liquify vapor as the main components




2 Long-tube vertical evaporator features forced-circulation through the tubes

## High-capacity evaporating plants must make best use of energy




3 Proposed distilling plant of large capacity would use 10 to 12 effects made up of long-tube vertical evaporators and heat exchangers for salvaging heat from brine and fresh-water condensate. Scale would be avoided by injecting slurry into water feed

chemical industry. Forced circulation of the sea-water feed through the tubes raises heat-transfer rates to as high as 1000 Btu per hr, sq ft, F. In addition, the water being heated stays only a short time in the evaporator and has little chance to build up scale on the tubes.

Investigators expect that sea water can be handled in the LTV evaporator with little corrosion of carbon-steel tubes. If so, expensive investment in alloy tubes will be avoided.

### Multi-effect evaporators

The huge capacity anticipated for future distilling plants makes fuel saving paramount. By going to multi-effect plants, Fig. 3, we can cut down on the fuel input at the expense of larger investment in more equipment. Investigators believe that by going to 10 and 12 effects an economic balance between operating and investment costs can be achieved.

In this type plant the vapor output of one effect acts as the heating steam of the next effect. Vapor output of the last effect gives up its heat in a condenser. Fresh water from all the effects discharges to a common header and heats the brine flowing between effects in stages. The brine discharge from the first effect also heats the incoming brine in the stage heaters. Slurry to act as seeds for solid deposition will be injected in the cycle where scale build-up tends to start.

### Flash evaporators

Flash evaporators aim at reducing the amount of heat-transfer surface needed in a distilling plant. They heat sea water under pressure and then throttle the water into a tank at lower pressure. Here, the water enthalpy exceeds the saturation enthalpy and a fraction of the water flashes to steam, leaving the salts in the water.

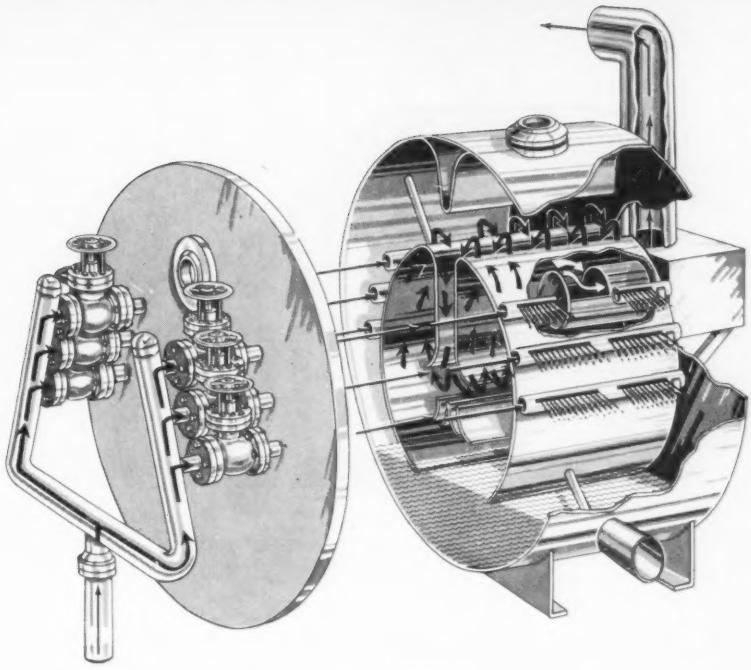
Fig. 4 shows an experimental flash evaporator designed for high-efficiency separation of water droplets and vapor. Pressurized, heated sea water enters through the left manifolds into the lower-pressure tank as thin sheets of water flowing through slots in the horizontal pipes. Vapor flashing from the "exploding" sheets makes turns of over 360-degrees to throw out entrained brine droplets which fall to the bottom of the tank to drain to waste or a lower stage. The vapor can be led out to an external condenser, or a cooling-water tube bundle and hotwell can be installed in the center separation section of Fig. 4 to make an integral evaporating unit. For more details see "Experimental flash evaporator . . ." by R L Coit and Y S Touloukian, POWER, Feb 1957, pp 92-95.

Fig. 5 shows a suggested multi-staging setup for these integral evaporating units. Heat input to the unit enters via the heater at top of the stack. Sea water acts as coolant for the fourth stage vapor, then part of this heated sea water enters the closed cycle as makeup to cool the vapor in the third, second and first stages. In the closed heater, the circulating sea water and brine heats to 200 F and then flashes successively in the four stages down to 120.5 F. Fresh water cascades through the effects, being cooled in stages by the brine coolant rising to the heater.

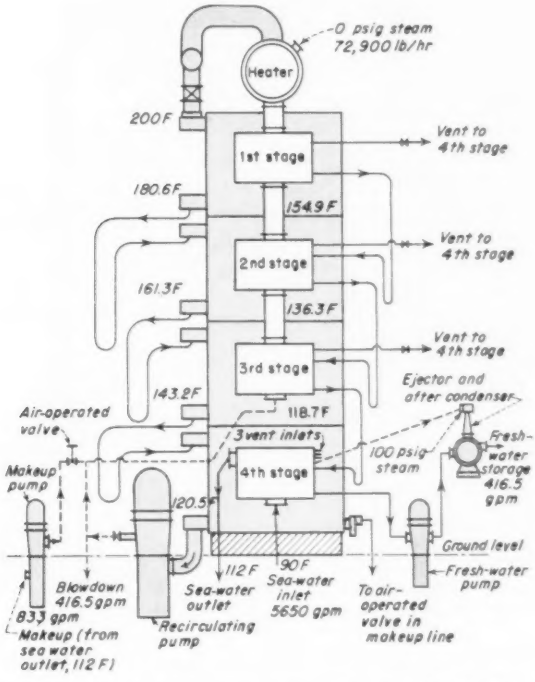
In another development of a flash evaporator, as the sea water goes from a higher- to a lower-pressure tank, the passage is shaped so flashing starts immediately. By the time the water-vapor mix enters the second tank it is a mass of finely-divided bubbles. Letting this cascade as a thin sheet to the tank bottom allows ample separating area with little carryover of brine droplets.

### Low-temperature flashing

Studies have been made of flashing warm sea water, such as would be dis-



4 Experimental flash evaporator injects sea water into lower-pressure area in sheets to give maximum release area for vapor. Tortuous vapor path throws out water drops




5 Four-effect flash-evaporator plant uses the units in Fig. 4 fitted with cooling-tube bundles in separator upflow sections

charged by condensers and oil coolers, into high-vacuum tanks. This method seems feasible where temperature differentials of 30 F are available between waste heat and natural cooling water. Even though the energy is free, the capital investment in water pumps, tanks, air pumps and other equipment make this method about 2½ times more costly than fuel-fired evaporating plants, Table 2. It's quite possible that further engineering studies will lower these costs.

## Vapor compression

This method of water distillation uses mechanical shaft work as the energy input, Fig. 6. Sea water is heated to 207 F in a heat exchanger by hot brine and fresh water leaving the unit. In the vertical-tube evaporator, the sea water is boiled by the 222-F 3-psig steam discharged by the compressor. Steam bubbles break through into the separation space while the brine leaves through the heat exchanger to waste. The 212-F 0-psig salt-free vapor enters the positive-displacement compressor to be raised to 222 F and 3 psig. The compressed vapor then re-enters the evaporator to boil the sea water in the tubes. This condenses the vapor which falls as fresh water to the bottom. It is drawn off through the heat exchanger to heat the incoming sea water.

Vapor compression plants were highly developed during World War II for military use. Plants are built now with capacities as high as 15,000 gpd for industrial use, using 75-hp compressor motor drives.

## Rotary stills

High heat-transfer rates pay off in needing smaller heat-transfer surfaces in evaporators. To boost this transfer, the rotary still of Fig. 7 was developed. This is a variation of the vapor-compression still. Sea water led in through a stationary pipe is sprayed on the upper and lower edges of a fast-spinning double cone. The sea water moves outward in a thin turbulent sheet over the inner surface of the cone. Heat from the higher-pressure vapor surrounding the outer surface of the cone partly evaporates the sea water. The brine flung to the wedge-shaped cone periphery is removed by a stationary scoop. The vapor flows down through the cone exit to the vapor compressor. The compressor pushes the pressurized vapor into the drum to surround the spinning cone.

In giving up its heat through the cone surface the compressed vapor condenses and falls to the drum bottom. This is drained off as fresh water. This unit uses an external heat exchanger as in Fig. 6. The fast-moving fluids boost heat transfer to as high as 3500 Btu per hr, sq ft, F. A

unit with eight cones is being tested, see the right-hand vertical tank in the photo on page 77.

## Electrodialysis

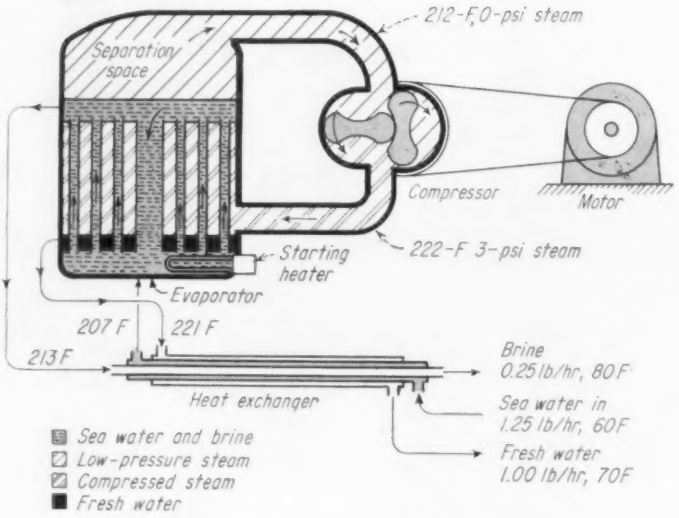
This method depends on the electric charges of ions dissolved in water to remove them from solution. When sodium chloride dissolves in water it separates into two ions—a sodium ion with a positive electric charge and a chlorine ion with a negative electric charge. A positive electrode immersed in a salt solution will attract the chlorine ions; negative electrodes attract sodium ions.

Using this action with ion-selective membranes, that will allow only one type of ion to pass through, offers a method of desalting brines. Fig. 9 is a membrane cell that produces fresh water from salt water by the electrodialysis method. Practical units consist of about 300 membranes. In our simple diagram we have the unit made up of alternate membranes; one type passes sodium ions but blocks chlorine ions, the other type acts oppositely. These cells work best on reducing brackish waters with 4000 ppm solids to about 350 ppm solids —but experimental work is being done with sea water also.

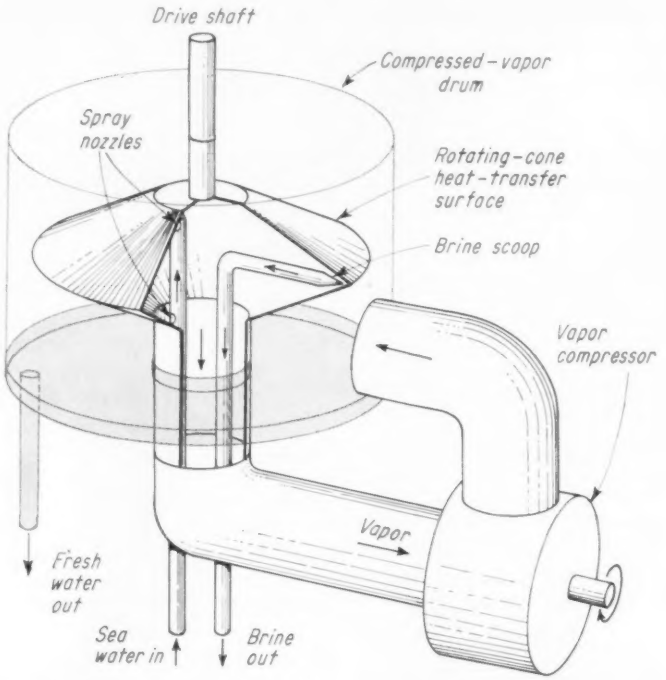
A negative electrode makes up one end wall of the cell and a positive electrode the other end wall. Brackish water enters the compartments between membranes. As soon as the ions enter the electric field between the electrodes the positive sodium ions flow toward the left negative electrode and the negative chlorine ions toward the right positive electrode.

Studying the center compartment, we see that sodium ions pass through the *M-M* membrane to the left, but are blocked by the succeeding *N-N* membrane to its left. The chlorine ions from the center compartment pass through the *N-N* membrane to the right, but are blocked by the succeeding *M-M* membrane. This alternate passing and blocking acts to remove the ions from alternate compartments and concentrate them in the neighboring compartments.

This means we can draw ion-free (salt-free) water from one set of alternate compartments and concentrated brine from the other set. Investigators believe further development will reduce costs of this method and make it feasible for sea water.

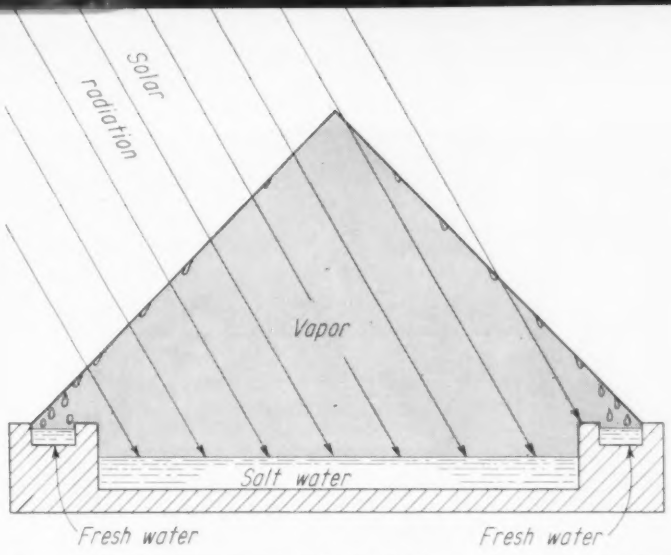



6 Vapor-compression distillation plant uses mechanical shaft work as the energy input which heats salt-free vapor by pressurizing it to 3-psig level

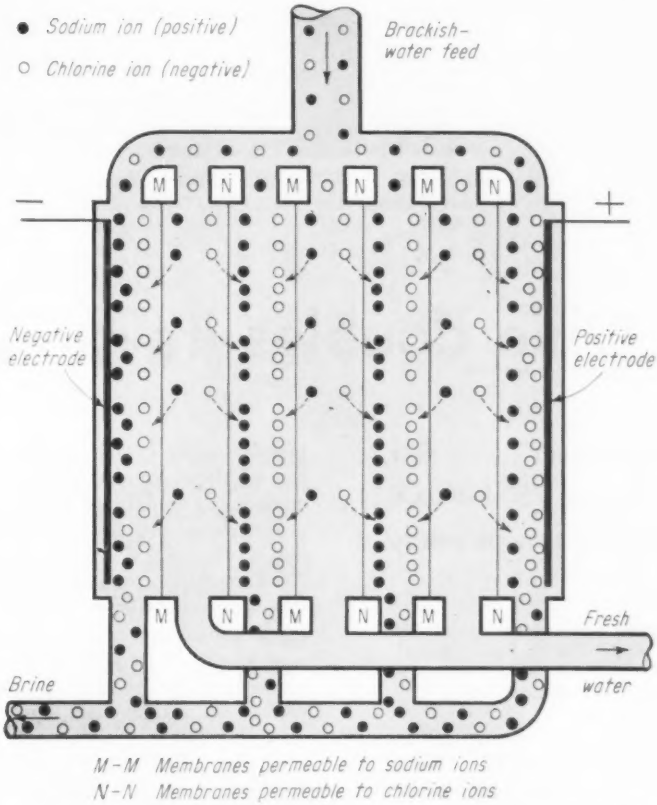



7 Vapor-compression distillation plant uses rotating-cone heat-transfer surface to boost heat-transfer rates to about 3500 Btu per hr, sq ft, deg F

Various types of membrane processes for separating ions from water are being studied in the laboratory. Osmionic separation depends on the concentration gradient between solutions to develop the electric potential for driving ions through membranes. Transport depletion tries to separate water by the difference in densities of ion-loaded and ion-free layers. Reverse osmosis pressurizes salt water to force water through a membrane that blocks ion passage. Biological membranes seek to use natural processes of separating salts from water that take place in animal bodies.




8 Solar-heated evaporator uses sun's radiant heat to evaporate (not boil) sea water. Vapor condenses on transparent roof, flows to side troughs




9 Electrodialysis unit has about 300 cells, this schematic shows only 7; selective membranes pass only positive *or* negative ions, not both, as shown

## Freezing separation

When salt water freezes, the ice crystals contain only pure water, but brine is trapped between the crystals. Methods must be developed to separate the tiny ice crystals and minute drops of brine to make this method of desalting practical for our use.

Laboratory tests have developed a method of producing ice slurries that are washed in a countercurrent separation column. This produces water with less than 500 ppm of solids. Estimates of costs for a full-scale plant make this method comparable with some present distillation methods.

An interesting project investigates the zone-freezing method of concentrating impurities. This method parallels the technique used in zone-melting of metals to concentrate impurities in one end of an ingot. Laboratory tests have produced water with 10 ppm impurity from sea water with a zone travel of ¾ in. per hr.

## Solar distillation

Attempts have been made periodically to imitate nature's water cycle in solar stills, Fig. 8. The sun's heat warms salt water flowing in a shallow trough in the bottom of the still. Pure water evaporates to produce a moderate-temperature vapor, somewhat warmer than the surrounding air. The vapor condenses on the transparent roof of the still. The drops collect and run down on the interior of the slanted roof to drain into troughs running along the edges of the pan.

This simple basic plan offers some challenging problems. Though the energy is free, the large surface needed for fresh-water production runs up capital costs. Research centers on finding suitable materials for the transparent roof and reducing the size of the components and auxiliaries, as well as maintenance costs.

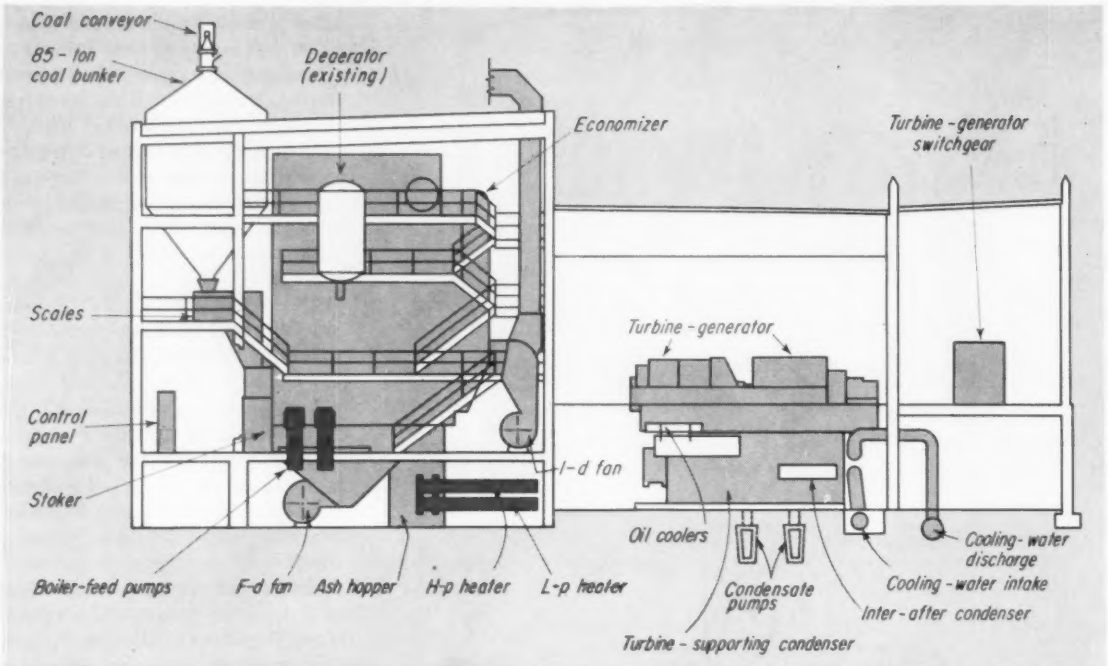
## Conclusion

Other methods for improving desalting processes are being investigated. Separation at supercritical conditions of over 3500 psig and 705 F seemed attractive because the high density of vapor indicated small-sized equipment. But high rate of scale build-up was found; no work was done to control scaling.

Another project has added minute quantities of nonobjectionable oil to the vapor of a distillation process. This produces dropwise condensation on the condenser tubes and aids in boosting heat-transfer rates to 2000 Btu per hr per sq ft.

Other ideas of using solvents to extract pure water from sea water, nuclear energy for heating, ultra-high-frequency currents, precipitation of salts are being or have been investigated as research projects.

For more detail on progress in this field see "Saline Water Conversion Report for 1957" issued by the United States Department of the Interior, in January 1958.




**COMPACT STEAM GENERATOR** squeezes 70,000 lb per hr in space of old 250-hp boiler. Unit accessibility keynotes design. New 6000-kw turbine-generator, with 7500-kw capability, was installed in area formerly occupied by 750-kw turbine-generator unit

# St. Mary's, Ohio doubles its rating

**A modern boiler replaced an old-timer . . . a new turbine-generator took over from a 750-kw unit. Result: power to grow and $25,000 savings yearly**

By F B PYLE, Vice President, Beiswenger, Hoch & Associates, Inc
F M CRAFT, Chief Engineer, City of St. Mary's Power Plant

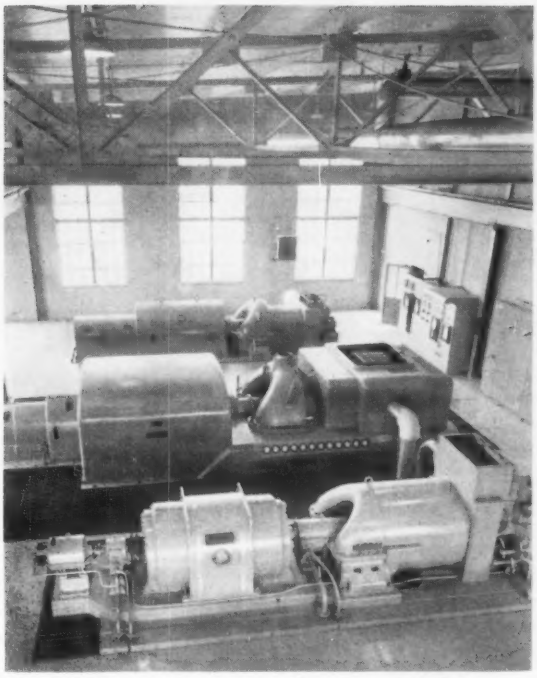
Many municipal power plants were caught short during the post-war boom. We were in that spot for several years. Then, because of a demand shift we got a breather. Instead of sitting tight, we decided to take advantage of our situation and increase plant capacity. Our goal: To double plant capacity without getting involved in costly building expansions. So, with careful selection, we shoehorned 6000-kw of additional power into the middle of our plant.

**New installation** included several interesting features which combined to give us a saving of $25,000 per year in fuel costs. We credit the savings to improved boiler efficiency, a better feed-heating cycle, reduced banking and standby loss, and higher turbine-throttle conditions. The most noteworthy features of our plant include 600-psig 825-F steam conditions for a 6-mw unit, a turbine-supporting condenser, vertical barrel-type feed pumps and gravity flow of circulating water through the condenser.

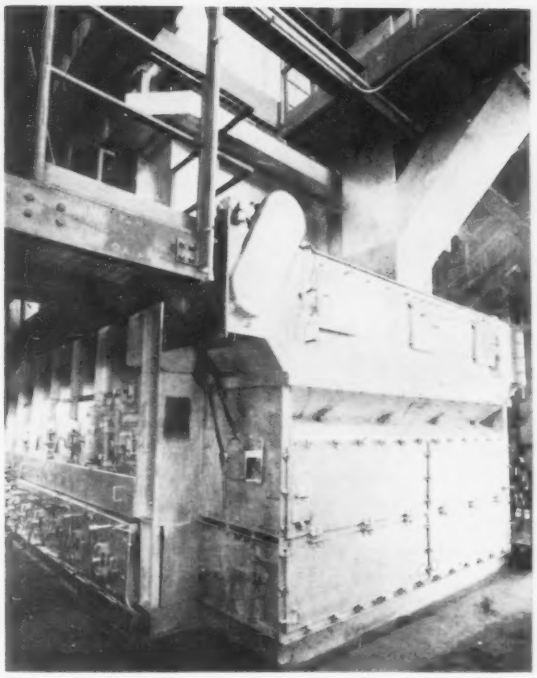
Although modern designs, higher pressures and temperatures greatly reduce space requirements, installing a tenfold increase in capability in a space that had been crowded by the former equipment raised design problems.

We chose throttle conditions of 600 psig and 825 F over the 400-psig, 750-F conditions usually employed in this size range. Higher pressures and temperatures were warranted, but it was not physically possible to install a boiler with the required superheater surface for higher conditions in the existing building.

**Boiler selection** was based on operating economies, construction features and maintenance requirements rather than first cost alone. The boiler selected best suited the available space. No compromise was necessary in grate area or furnace volume. The boiler design stands out because of its flat superheater characteristic. Careful consideration was given to providing convenient access by stairs and platforms for service and inspection of valves, doors, soot blowers and manholes.



**NEW UNIT** stands between two older units, uses higher steam pressure, temperature to gain efficiency and capacity advantage



**FULLY ENCLOSED STOKER** and coal system reduces problem of coal dust and serves to maintain neat appearance of the plant

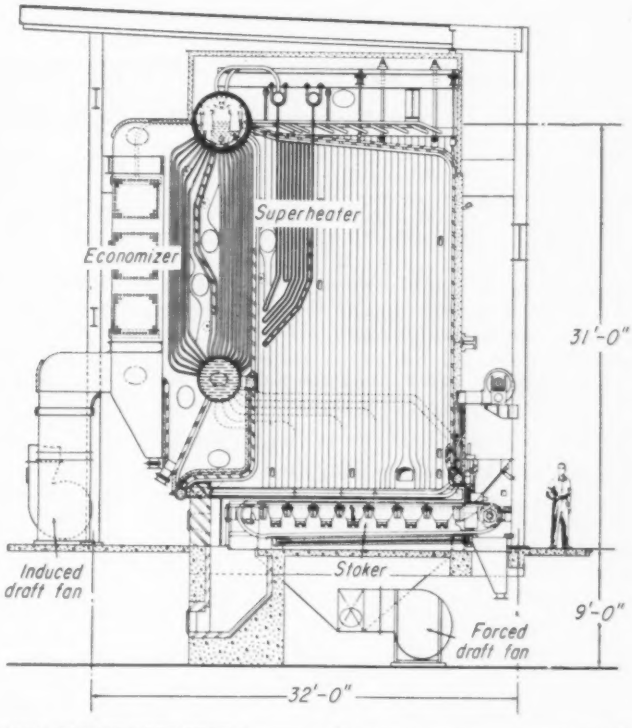
# in same space

Chain grate stoker burns Ohio coals without space-consuming and expensive auxiliaries. This stoker can save an extra $6000 a year by burning lower grade coals than the older units can handle efficiently. A distributing coal feeder is used to maintain unsegregated feed to the stoker. This design prevents bunker segregation carrying through to stoker.

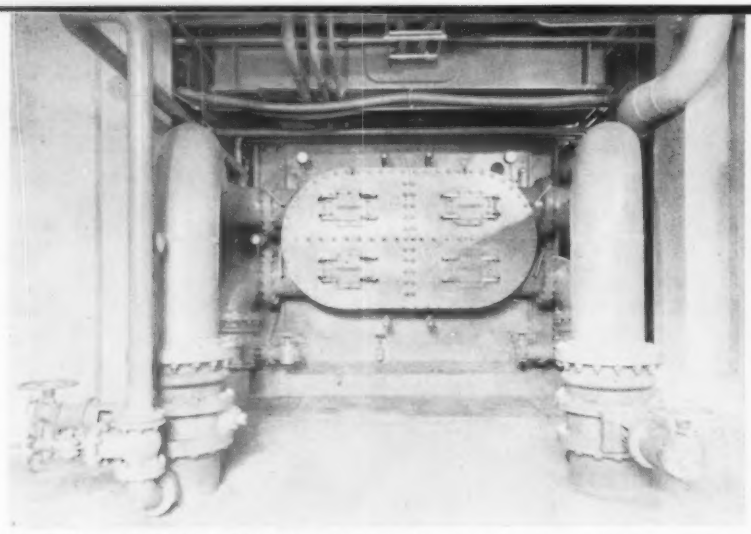
We recirculate flue gas in this unit in increasing proportions as load decreases. By this means, the manufacturer's predicted superheat increases 15 to 25 F over its design value at one-quarter load, and efficiency improves at light loads.

Turbine-supporting condenser conserves valuable headroom and space in the condenser room, and reduces dead load on the foundation. Loading on the relatively poor soil was maintained at original values so extra piling in the area between older units was unnecessary.

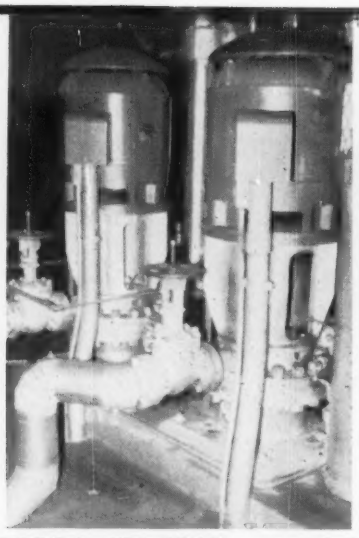
Vertical barrel-type feed pumps for




**NEW STOKER-FIRED UNIT** features a flat steam-temperature curve. High-velocity air jets replace conventional furnace arch for ignition stability



**TURBINE-SUPPORTING CONDENSER** for the 6-mw unit reduces headroom requirements and dead load on foundation. Circulating-water lines feed divided waterboxes



**VERTICAL FEED PUMPS** use one-third of space required by two horizontal units

this service cost less than horizontal split-case pumps and need one-third as much floor space. The new unit uses two full-size, motor-driven, vertical boiler-feed pumps, and an existing steam-driven pump, which was reimpellered for emergency use.

**Circulating water** flows by gravity through the condensers. Water is available from the feeder canal of the historic Miami-Erie Canal. The feeder canal supplies a 16-ft head, and the discharge flows into the lower canal. Circulating-water pumps are not employed for normal operation, but existing pumps serve as standby units to recirculate from the lower canal in case emergency situations crop up.

Feedwater heating cycle uses two new closed heaters in series with existing deaerating heater. The three heaters combine to deliver feedwater to boiler at a temperature of 340 F.

**Other features** include using welded-end valves to the maximum extent practical. Single-layer pipe insulation with aluminum jacketing was used to simplify maintenance.

Plant personnel built the pressure filters for feedwater makeup using drum heads from the old boiler, which was demolished. They also installed the zeolite softener and piping.

## PRINCIPAL POWER-PLANT EQUIPMENT

### St. Mary's, Ohio Municipal Electric Plant — Unit 5

Turbine-generator, 1 — Worthington Corp
7500 kva, 7200 v, 3 ph, 60 cycle, 6000 kw at 0.8 pf, 7500 kw capability, 3600 rpm, 600 psig, 825 F, 2 in. Hg exhaust, twin air coolers

Condenser, 1 — Worthington Corp
Turbine supporting condenser, 7250-sq-ft surface, 12.1-ft friction loss at 6700 gpm, 85% clean, two 150-gpm condensate pumps, 160 ft tdh, gravity flow cooling water

Steam generator, 1 — Babcock & Wilcox Co
Two-drum Stirling, 70,000-lb-per-hr continuous, 75,000-lb-per-hr two-hour peak, 600 psig, 825 F, pendant superheater, continuous tube economizer

Stoker, 1 — Babcock & Wilcox Co
"Jet ignition" chain grate, 189-sq-ft area, 534,000 Btu per sq ft of grate area at peak load, 26,100 Btu per cu ft of furnace volume at peak load

Coal scale and chutes — Stock Equipment Co

Coal bunker and supports — C A Hooper Co

Forced draft fan, 1 — Green Fuel Economizer Co
131,000 lb air per hr at 9.5 in. wg. Electric-motor drives 60 hp 1800 rpm, and 30 hp, 1200 rpm

Induced-draft fan, 1 — Green Fuel Economizer Co
125,000 lb gas per hr at peak load. Electric-motor drives, 125 hp, 1200 rpm, and 75 hp, 900 rpm

Soot blowers — Diamond Power Specialty Corp
Electric pushbutton operated

Combustion and turbine controls — Hagan Chemicals & Controls, Inc

Feedwater heaters, 2 — Condenser Service and Engineering Co
Horizontal closed-type, h-p heater—130 psig, 5,950,000 Btu per hr, l-p heater—10 psig, 5,010,000 Btu per hr

Boiler-feed pumps, 2 — Ingersoll-Rand Co
Vertical multistage, centrifugal pumps, 160 gpm each, 2000-ft tdh, 150 hp, 3600 rpm

Ash-handling equipment — United Conveyor Corp
Addition to existing pneumatic ash-conveyor system

Main switchgear — Westinghouse Electric Corp
Substation rating—750 kva, 60 cycles, 3 ph; incoming 3-wire circuit, 7200 v or 12,470 v; outgoing 3-wire circuit, 480 v

Boiler nonreturn valve — Edward Valves, Inc

Class-I valves, 2½ in. and larger — Crane Co

Class-I valves, 2 in. and smaller — Lunkenheimer Co

Class-II valves, 2½ in. and larger — Manning, Maxwell & Moore, Inc

Class II valves, 2 in. and smaller — Edward Valves, Inc

Class-IV valves — Edward Valves, Inc

Circulating-water butterfly valves — Henry Pratt Co

Bleeder check system — Schutte & Koerting Co

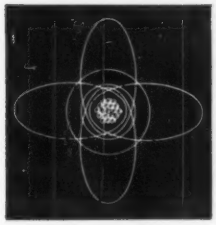
Building construction and mechanical work — C A Hooper Co

Electrical fabrication — Heckler Hardware Co

Boiler erection — Babcock & Wilcox Co

Machinery erection — Worthington Corp

Consulting engineers — Beiswenger, Hoch & Associates, Inc



# Nuclear notes

By B G A SKROTZKI, Associate Editor

**Heavy-water cooled and moderated** pressure-tube reactor plant to produce net of about 17 mwe has been proposed by Carolinas Virginia Nuclear Power Associates. They have reached agreement with AEC on a basis for contract arrangements. Plant will be built at Parr Shoals, 25 miles north of Columbia, S. C., to start mid-1962. Stone & Webster will be engineer-architect and Westinghouse will develop and build equipment. Associates will pay about $22 million and the AEC about $14.7 million. Associates include: Duke Power, S. C. E&G, Carolina P&L and Virginia E&P Co.

**Sodium reactor experiment** (SRE) in Santa Susana Mountains, 30 miles NW of Los Angeles, has reached its design power level of 20 mwt. The unit built and operated by Atomics International for the AEC sells its heat to Southern California Edison for generation of 6 mwe.

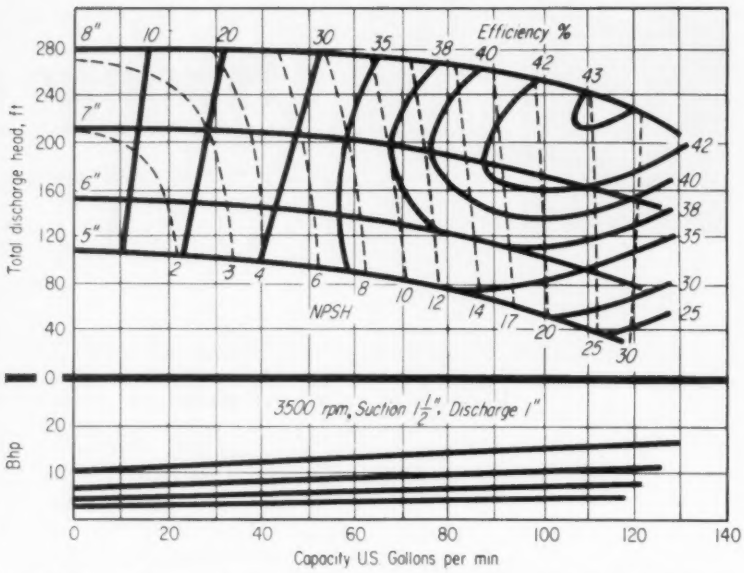
**Experimental boiling-water reactor** plant at Argonne National Laboratory has been shut down because its 5-mw turbine has lost a blade, after more than 3000 hours operation. Inspection could be made immediately because radioactivity right after shutdown was only 2 milliroentgens per hr. This low activity is remarkable because unit was running about a week with a deliberately impaired fuel sample in reactor core. Permissible exposure for personnel is limited to 3000 milliroentgens within three months and an average of 5000 per year.

**1959 Nuclear Congress** will be held at the Cleveland Auditorium in Ohio on April 5-10. Paper outlines must be submitted before Oct 1, 1958 to any of the secretaries of the sponsoring societies. The congress, as in the past, will include: Nuclear Engineering & Science Conference, Atomic Energy Management Conference, Hot Laboratories and Equipment Conference, and the Atomfair. For information write: T A Marshall, Jr, Engineers Joint Council, 29 West 39th Street, New York 18, New York.

**Army Package Power Reactor** (APPR-1A) will be built at Fort Greely near Fairbanks, Alaska by Peter Kiewit Sons Company of Omaha. Alco Products, Inc, will furnish the entire nuclear system, as a subcontractor, for the 1700-kw pressurized-water nuclear plant. New station will produce twice the heat output from the same size core used in first APPR at Fort Belvoir, Va. With exception of core and its fuel elements, primary system components will be larger. About half of heat will be used in turbine, the rest for space heating. Plant will start about 1960, and place current oil-fired plant on standby. Plant will produce 1.5 mwhr from one pound of enriched uranium to displace 110,000 gal diesel oil now needed.

**Radiocarbon-14** allows dating objects as old as 40,000 years plus or minus about 3 centuries. Recorded history goes back less than 5000 years. Many measurements show that last ice age hit North America and Europe about 11,000 years ago. This technique depends on cosmic-ray bombardment of the atmosphere forming neutrons that are absorbed by the nitrogen to form carbon-14. The C-14 has a half-life of 5600 years, but the total on earth stays constant. Living things absorb C-14 in their food, keeping the concentration in their bodies constant during their lifetime. But once they die they can't take in any more C-14; so by measuring the decay activity of C-14 in deceased matter scientists can estimate how long ago it died.

**CHEMICAL PUMPS** handle a wide variety of corrosive solutions in industrial plants




**PERFORMANCE CURVES** show that a centrifugal pump develops a definite head for any specific capacity. But discharge pressure will vary with specific gravity of the liquid

# Selecting centrifugal chemical pumps

**Ordinary centrifugal pumps for water service are usually unsuited for chemicals and other corrosive solutions. Here's basic data to help you choose correct chemical pump material, design and size**

By R B WOOSTER, The Duriron Company, Inc

Most chemical and process industry engineers are familiar with a certain type of centrifugal pump that's come to be known as the "chemical pump." From experience they know that an ordinary pump, for water service, shouldn't be used for chemicals and other corrosive solutions.

Competitively designed, light duty, cast-iron or bronze-fitted pumps aren't suitable for pumping (1) sulfuric-acid pickling liquor (2) muriatic acid for boiler-tube cleaning (3) electroplating solutions (4) water- and waste-treatment chemicals and (5) many other nonaqueous liquids that frequently crop up. Their design is not rugged enough for severe or continuous service and 3500-rpm operation. This is particularly true when greater loads are imposed on bearings and shaft by liquids heavier than water.

If you are faced with the problem of specifying pumping equipment for these services, here's basic data to help you select right materials of construction, pump design and size.

**First step** is to choose materials of construction for the pump. This isn't as difficult as it may appear, even though the solution handled may be corrosive or otherwise unusual or unique. More is learned every day about different forms of corrosion and the mechanism of corrosion resistance. But there's also danger in oversimplifying the problem.

Many factors affect build-up and maintenance of the molecularly-thin protective film that forms on a corrosion-resisting material. For example, it's an oxide film on stainless steel that makes it resistant to nitric acid. Time is required for the film to build up. Relative velocity between film and liquid is important. Temperature is critical because it affects (1) solubility of dissolved gases (2) solubility of initial corrosion products actually making up the film and (3) the overall corrosion rate. Strength of chemicals in the liquid is also important. Although concentrated sulfuric acid can be handled easily in cast iron, the dilute acid is extremely corrosive to ordinary materials of construction. Minute traces of contaminants and impurities often change the entire aspect of the environment.



Perforated for your filing ease

## 11 attributes of the ideal chemical pump

1 Comes in a wide range of metallic alloys and even plastics. Wet end on each pump is interchangeable from one alloy to another

2 Uses semiopen rather than a closed impeller, allowing pump to handle slurries, liquids with solids in suspension and clear liquids

3 Has flanged connections since pipe threads are far too susceptible to corrosion

4 Machining of bearing bores and other piloting surfaces in bearing housing or power end is precise and concentric. Otherwise shaft runout or eccentricity will be high, posing sealing problems. Usually a solid-alloy shaft runs truer than one in shaft-sleeve construction. Tolerances for the shaft and sleeve inside and outside diameter may build up in the wrong direction. This will lead to greater eccentricity than a solid shaft with its single machining operation

5 If packed stuffing box is used, the packing is lubricated and cooled on other than water service

6 Stuffing box is suitable for installing a mechanical seal, if desired. Mechanical seal and conventional packing are interchangeable

7 There is adequate room between end of stuffing box and first obstruction on the shaft to facilitate repacking, permit use of any type mechanical seal

8 Gland leakage is removed so pump baseplate and bearing housing are not subjected to corrosion

9 Shaft is heavy enough to minimize deflection, particularly on liquids heavier than water, so either packing or a mechanical seal can do a satisfactory job of shaft sealing

10 Oil and grease for bearing lubrication is protected from corrosive liquids and vapors by use of shaft closures and slingers

11 Bearings are heavier than those used in water pumps to take care of heavier loads, longer operating periods and, generally, more severe conditions

But answers to questions on corrosion are more readily available now than ever before. And the job will get easier as new metallic alloys and plastics come into the picture.

It is a unique situation when you are faced with the problem of pumping something that has not been pumped before. Chart, page 90, summarizes the corrosion resistance of typical materials to a wide range of chemical solutions. If yours is the exceptional case and data is not available, then corrosion tests are in order. These can be run either in the laboratory or in the plant with samples or small-sized equipment.

**Next step,** once the material of construction is fixed, is to choose a pump design. Look for one that incorporates as many as possible of the attributes of the ideal chemical pump listed above.

**Final step,** after picking a suitable design, is to size the pump and its driver. First, decide on the flow in gpm. Then, calculate pressure drop through pipe, fittings and valves in the system using standard hydraulic tables. This is the dynamic head; vertical distance, in feet, that the liquid must be raised is the static head. Add both of these to any desired pressure at end of line to get total dynamic head that the pump must produce for the system.

**Chemical-pump sizing** calls for special attention because specific gravity of the liquid often is something other than 1. Pump performance curves are customarily plotted in feet of head. So, at some point, pressure in psi must be converted to feet. To do this, multiply psi by 2.31 and divide by the specific gravity. But don't make any allowance for specific gravity in figuring the static head.

Typical pump performance curves, facing page, show that a centrifugal pump will develop a definite head for any specific capacity. Specific gravity of the liquid doesn't affect this head in feet. But it will affect the pump discharge pressure.

To illustrate, let's take two identical pumps and connect the discharge nozzle of each to standpipes that extend 100 ft upward. One pump will handle water, the other concentrated sulfuric acid with a specific gravity of 1.8. From the performance curve we know that each pump is capable of delivering the needed 100-ft head.

Start the pumps and you'll find that each will raise the liquid 100 ft, filling the standpipe to the top. But what about the discharge pressure?

Pressure at the discharge nozzle of the water pump is equal to 100 divided by 2.31, or 43 psi. For the sulfuric acid pump it's 100 divided by 2.31 and multiplied by 1.8, or 78 psi. Discharge pressure of the acid pump is higher because centrifugal-pump pressure varies with the mass of liquid whirled about between impeller vanes on its path through the pump volute. Once all pressure units are correctly converted to feet, the same pump performance curve can be used even though solution isn't water.

This point is emphasized because most ordinary pumping problems involve water where gravity correction isn't needed. It's surprising how many qualified engineers either forget to take gravity into account in converting from psi to feet, or do it incorrectly. One common mistake is adjusting head points on a performance curve for gravity.

When sizing the motor, note that

## This chart is a handy guide to materials of construction

| | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Acetate solvents | A | A | A | A | A | |
| Acetic acid, all strengths | A | A | B | B | A | C |
| Acetic anhydride | A | A | B | B | A | |
| Alum | A | A | B | B | B | B |
| Aluminum chloride | B | A | C | A | B | A |
| Aluminum sulfate + $H_2SO_4$ | A | A | B | B | B | B |
| Ammonium chloride | B | A | B | A | A | A |
| Ammonium fluoride with sodium bisulfate | D | D | B | | B | B |
| Ammonium hydroxide | | | A | A | A | B |
| Ammonium nitrate | A | A | A | B | A | A |
| Ammonium phosphate | A | A | B | B | B | A |
| Ammonion sulfate | A | A | A | B | A | A |
| Ammonion sulfate + $H_2SO_4$ | A | A | B | B | B | B |
| Aniline dyes | A | A | B | A | A | C |
| Aniline hydrochloride | | B | C | | | |
| Anodizing solutions | B | B | B | | B | |
| Antimony trichloride | B | A | C | | B | A |
| Arsenic acid | A | A | B | A | A | |
| Barium chloride | A | A | B | B | A | A |
| Barium nitrate | A | A | A | B | A | A |
| Barium sulfate | A | A | B | A | A | A |
| Benzoic acid | A | A | A | A | A | B |
| Black liquor | B | | B | B | B | |
| Boric acid | A | A | B | A | A | |
| Brine | A | A | B | A | A | A |
| Bromine, dry | C | C | C | | B | |
| Butyric acid | A | A | A | B | A | C |
| Cadmium sulfate | A | A | A | A | A | A |
| Calcium bisulfite | D | D | B | | B | |
| Calcium bisulfite + $H_2SO_4$ | D | D | B | | B | |
| Calcium chlorate | B | B | B | | A | A |
| Calcium chloride | A | A | A | A | A | A |
| Calcium hypochlorite | B | A | C | D | B | B |
| Calcium phosphate | A | A | B | B | A | A |
| Carbolic acid | A | A | A | A | A | B |
| Carbon bisulfide | B | B | B | | A | |
| Carbonic acid | A | A | A | A | A | B |
| Carbon tetrachloride | A | A | B | B | A | B |

| | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Cellulose acetate | A | A | B | B | A | |
| Chloroacetic acid | | B | D | D | B | C |
| Chlorinated water | B | B | C | D | B | B |
| Chlorine gas, moist, at room temperature | C | B | D | D | B | B |
| Chromic acid | A | A | C | D | C | C |
| Citric acid | A | A | A | B | A | B |
| Copper nitrate | A | A | A | | A | A |
| Copper silver nitrate | A | A | B | | A | B |
| Copper sulfate | A | A | A | B | A | A |
| Copper sulfate + 10% $H_2SO_4$ | A | A | B | B | B | B |
| Cupric chloride | D | C | D | D | C | A |
| Cuprous chloride | A | A | B | | A | A |
| Ethylene dichloride | B | A | C | B | B | C |
| Fatty acids | A | A | A | A | A | A |
| Ferric acetate | A | A | A | | A | |
| Ferric chloride | D | C | D | D | C | B |
| Ferric ferro-cyanide (Prussian blue) | A | A | B | B | A | A |
| Ferric nitrate | A | A | A | | A | B |
| Ferric sulfate | A | A | A | B | A | A |
| Ferric sulfate + 10% $H_2SO_4$ | A | A | B | | B | A |
| Ferrous sulfate | A | A | A | A | A | A |
| Ferrous sulfate + 10% $H_2SO_4$ | A | A | B | A | B | A |
| Formaldehyde | A | A | A | A | A | |
| Formic acid (and with acetic acid) | A | A | B | B | A | C |
| Gallic acid | A | A | A | A | A | |
| Glycerin, crude | A | A | B | | B | |
| Hydrochloric acid (below 150 F) | C | B | D | B | C | A |
| Hydrochloric acid (over 150 F) | D | C | D | B | D | B |
| Hydrofluoric acid | D | D | B | B | B | B |
| Hydrofluosilicic acid | D | D | B | B | B | B |
| Hydrogen peroxide | B | B | B | D | B | |
| Hypochlorite bleach | B | B | C | D | B | B |
| Iodine, dry | B | B | C | | B | |
| Lactic acid | A | A | B | B | A | B |
| Lead acetate | A | A | B | A | A | B |
| Lead nitrate | A | A | A | | A | B |
| Lead sulfide | B | B | | B | B | |
| Lithopone | B | B | A | | A | |

## Here's the key to evaluating these typical materials

**1 High silicon iron**
(Duriron)
Silicon 14.5%
Carbon 0.85%
Manganese 0.65%

**2 High silicon iron**
(Durichlor)
Silicon 14.5%
Carbon 0.85%
Manganese 0.65%
Molybdenum 3.00%

**3 Austenitic stainless**
(Durimet 20)
Nickel 29.00%
Chromium 20.00%
Molybdenum 2.00% min
Copper 3.00% min
Silicon 1.00%
Carbon 0.07% max

**4 Nickel moly alloy**
(Chlorimet 2)
Nickel 62.00%
Molybdenum 32.00%
Iron 3.00% max
Carbon 0.10% max
Silicon 1.00% max

**5 Nickel moly chrome alloy**
(Chlorimet 3)
Nickel 60.00%
Molybdenum 18.00%
Chromium 18.00%
Iron 3.00% max
Carbon 0.07% max
Silicon 1.00% max

**6 Epoxy resin**
(Durcon)
A nonmetallic possessing excellent corrosion resistance to a wide variety of materials while retaining desirable mechanical properties of high impact resistance and low moisture absorption

**A** Excellent—virtually unattacked under all conditions

**B** Good — generally acceptable with a few limitations

**C** Satisfactory—suitable under many conditions; not recommended for remainder

**D** Poor — unsuitable under all conditions

## when selecting pumps to handle these chemical solutions

| | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Magnesium chloride | B | A | B | B | A | B |
| Magnesium sulfate | A | A | B | A | B | B |
| Maleic acid | B | B | B | B | A | |
| Malic acid | A | A | A | A | A | |
| Manganese chloride | B | A | B | B | A | A |
| Mercuric chloride | D | C | D | D | C | B |
| Mercuric nitrate | A | A | A | | A | |
| Mercuric sulfate | A | A | A | B | A | A |
| Mercurous sulfate | A | A | A | A | A | A |
| Metal plating solutions | B | B | C | C | C | C |
| Mine water | B | B | B | B | A | |
| Mixed acid | A | A | B | D | C | D |
| Nickel chloride | A | A | B | A | A | A |
| Nickel ammonium sulfate | A | A | A | A | A | B |
| Nicotine sulfate | A | A | A | A | A | |
| Nitric acid, all strengths | B | B | B | D | C | C |
| Nitric acid +3% to 5% HF | D | D | C | D | C | B |
| Nitrobenzene | A | A | A | A | A | C |
| Oleic acid | A | A | A | A | A | |
| Oleum | D | D | B | B | B | D |
| Oxalic acid | A | A | B | B | B | B |
| Phenol | A | A | A | B | B | D |
| Phosphoric acid—concentrated C.P. | A | A | B | A | B | |
| Phosphoric acid +3% HF | D | D | B | B | B | B |
| Picric acid | A | A | A | A | A | |
| Phthalic acid | A | A | B | B | B | B |
| Potassium bisulfate | A | A | A | | A | B |
| Potassium chlorate and hydrochloric acid | C | B | D | | C | |
| Potassium chloride | A | A | B | B | A | A |
| Potassium hydroxide | C | C | B | A | A | B |
| Potassium iodide | B | B | | | B | |
| Potassium nitrate | A | A | A | | A | A |
| Potassium sulfate | A | A | A | A | A | A |
| Pyridine sulfate | A | A | B | A | A | |
| Pyrogallic acid | A | A | A | | A | |
| Pyroligneous acid | A | A | B | | A | |
| Sea water | B | B | B | B | A | B |
| Sodium bicarbonate | A | A | A | A | A | B |

| | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Sodium bichromate | B | B | B | | B | |
| Sodium bisulfate | A | A | A | B | A | A |
| Sodium bisulfite | D | D | A | | A | |
| Sodium chlorate | B | B | B | | B | |
| Sodium chloride | A | A | A | B | A | A |
| Sodium ferricyanide | A | A | B | B | A | |
| Sodium hydroxide | C | C | B | A | A | C |
| Sodium hydroxide, fused | D | D | D | C | C | D |
| Sodium hypochlorite | B | B | C | D | B | B |
| Sodium nitrate | A | A | A | | A | A |
| Sodium perchlorate | B | B | | | B | |
| Sodium phosphate | B | B | B | B | B | A |
| Sodium sulfate | A | A | A | A | A | A |
| Sodium sulfide | B | B | B | B | B | B |
| Sodium sulfite | D | D | A | | A | |
| Sodium thiosulfate | A | A | A | A | A | A |
| Stannic chloride | C | C | D | D | C | B |
| Stannous chloride | B | B | B | B | B | A |
| Stearic acid | A | A | A | A | A | |
| Sulfite liquors (calcium and sodium bisulfite) | D | D | B | | A | |
| Sulfite liquors + $H_2SO_4$ | D | D | B | | B | |
| Sulfur | B | B | B | | B | |
| Sulfur chloride | C | A | | | B | |
| Sulfur dioxide | D | D | A | | A | |
| Sulfuric acid, to 150 F | A | A | B | A | B | B |
| Sulfuric acid, 60-100%, to 176 F | A | A | B | A | B | C |
| Sulfurous acid | D | D | B | | A | |
| Sugar solutions | A | A | A | A | A | |
| Tannic acid | A | A | B | A | A | A |
| Tanning liquors | A | A | B | B | B | |
| Tar and ammonia | | | B | | B | |
| Tartaric acid | A | A | B | B | B | |
| Titanic sulfate | A | A | B | B | B | |
| Toluol | A | A | A | A | A | B |
| Urine | A | A | A | A | A | B |
| Vegetable juices or Vinegar | A | A | A | A | A | |
| Zinc chloride | B | A | B | B | A | A |
| Zinc sulfate | A | A | A | B | A | A |

the performance curve also gives required bhp based on water. Horsepower increases with pump capacity, and also directly with specific gravity. If a water pump calls for 5.0 bhp at the operating point, a similar sulfuric acid pump needs 5 multiplied by 1.8, or 9 bhp.

After fixing head-capacity conditions the search for a proper size pump begins. It's not practical for any one manufacturer to have more than a certain number of sizes in his line of pumps. So the desired combination of head-capacity conditions will often fall between sizes. Fortunately, standard equipment can be adapted and modified by varying speed, impeller diameter, etc.

**Pump speed** greatly influences size. Most chemical pumps today are driven by electric motors, except for rare cases where turbines are used for operation during power failure. So pump speeds are usually restricted to 1150, 1750 or 3500 rpm.

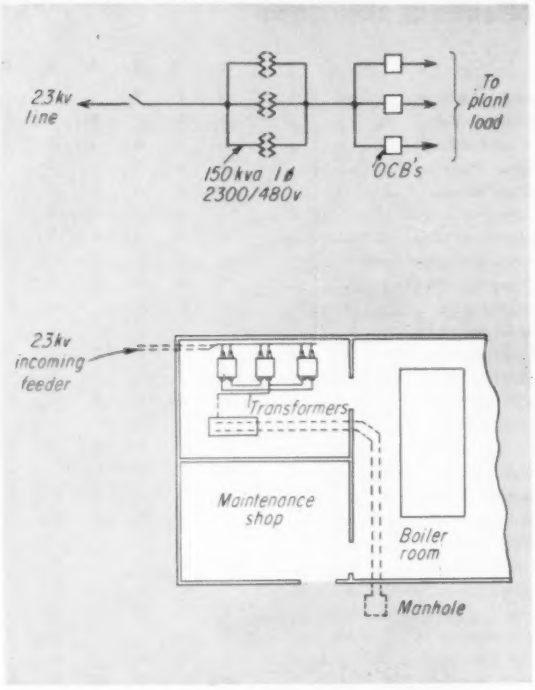
Capacity delivered by the pump varies directly as the speed of operation. The head developed is proportional to ratio of squares of the speeds. For example, increasing speed of a 100-gpm pump from 1750 to 3500 rpm ups capacity to 200 gpm. If the head produced at 1750 rpm is 50 ft, it will increase to 200 ft at 3500 rpm.

Most chemical pumps today are driven at 1750 rpm, so this speed is arbitrarily selected by most users. Although standardizing on 1750 rpm would make things easy, it's by no means the wisest choice. First, look at what the two other common synchronous speeds have to offer.

**Operating at 1150 rpm** means a relatively large pump for any one pumping job. But it can often be economically justified for handling abrasive slurries. It greatly extends shaft life in the stuffing-box area with either conventional packing or a mechanical seal. Another reason for using this speed is to meet a normally low available NPSH (net positive suction head). NPSH needed at 1150 rpm is about four-ninths that required for pump operation at 1750 rpm.

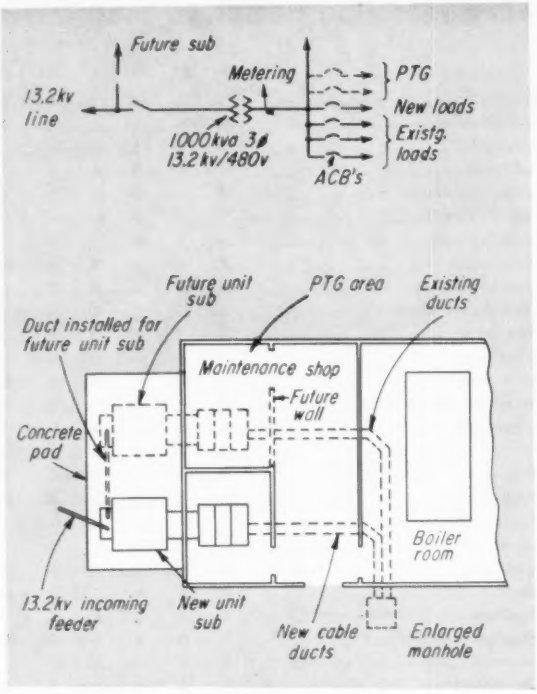
**Pumps driven at 3500 rpm** are much smaller and considerably less expensive. There has been some resistance to operating chemical pumps at this speed because the early chem-

(*Continued on page* 162)




**Plant in a tight spot electrically . . .**

Layout here is similar to that found in many plants. Small indoor transformers were unable to cope with plant's fast-growing load




**Same plant with a PTG index of 2**

By adding a concrete pad outdoors, placing switchgear indoors, capacity was quadrupled without materially changing space needs

# PTG designs for primary subs can be

**Oil-filled transformers, spotted right outside a plant, often prove the best bet. But always explore the economics of running supply voltage indoors, directly to secondary subs**

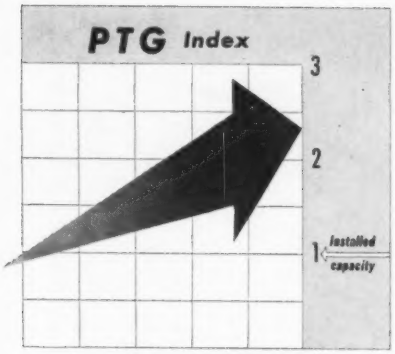
One of the frequent gripes heard by POWER editors in connection with the current Power to grow . . . *electrically* program is the costly space required to provide for tomorrow's growth. That's not always so. More often than not, the space problem can be licked by simple common-sense juggling. Here's an example of what we mean.

**A small plant** making paper boxes had loads tacked on here and there until all space capacity vanished. To cope with the fast-rising demand, a bank of three single-phase transformers was replaced with others, upping capacity to 450 kva. But this was only a temporary stopgap.

Six months later the production people decided to add another corrugating machine. The electrical picture, already bad, became impossible. Some major changes were needed, fast. Incoming primary sub was spotted smack alongside the maintenance workshop at one end of the boiler room. And there was no apparent space for electrical expansion. The power man got the word to "double electrical capacity, don't interrupt production, keep costs in line." He figured a 1000-kva unit sub with four fully rated circuit breakers plus space for two more would do the trick. The local utility was in a position to drop the present 2.3-kv feed and run in a new high-voltage feeder at 13.2 kv.

**The power man** wrestled with three possible unit-sub arrangements: (1) Outdoor weatherproof (2) Indoor in a new building (3) Outdoor transformer and primary switch with indoor feeder switchgear. When the cost figures were analyzed the third arrangement proved most feasible, since there was only a slight premium for weatherproofing the oil-filled transformer. Using indoor equipment in a new building ran a close second.

**Some construction** was needed to make the proposed scheme workable. A concrete pad was poured to take the one new and one future transformer. Also, relocation of the main-




### Using the PTG index?

You're missing a good bet if the PTG index hasn't, by now, found its way into your planning. It can be a prime gage for consultants, plant engineers and electrical engineers alike. When boiled down, it's simply a practical indicator you should use to measure a plant's *grow-ability*.

An index of *1* means electrical expansion would be quite costly. Your index is *2* if you can double capacity without straining.

# space savers

tenance shop allowed cutting in the new ducts. And the existing manhole enlargement was worked out to handle existing and future ducts.

An opening was cut in the boiler room's outside wall to take new duct-run between transformer secondary and indoor switchgear. This was being done while the new 13.2-kv feeds were run in. The changeover was made over a weekend after all materials and equipment were on the job. Corrugator and its auxiliaries were installed; the unit sub erected.

**Windup** left the plant with primary sub capacity up about 200% with little disruption and moderate cost. Plant now sports a PTG index of 2, another 1000-kva transformer with switchgear may be added easily when the need arises. And when that time comes a double-ended sub arrangement can readily be worked out.

## Transmission voltages reach for 750 kv as a PTG step

**MODEL TOWERS** of General Electric Co's extra-high voltage line dwarf a 110-kv transmission tower built to the same scale

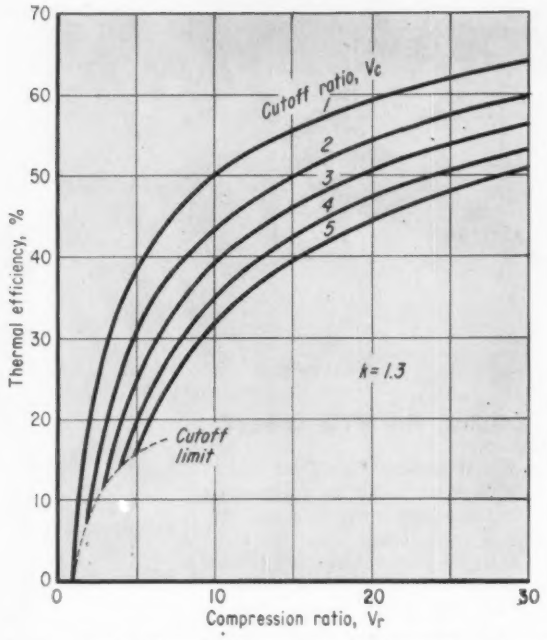
With a display of future planning characteristic of the electric-utility industry, present limits of EHV (extra-high-voltage) are being pushed even further. Reason: To cope economically with tomorrow's load growth. This latest step was taken last month when G.E. and Western Massachusetts Electric Co announced plans to erect a 4.5-mile transmission line capable of operating at 750 kv (for details see p 134).

This move to climb above the present 340-kv top (in the United States) may well prove the opening move to a country-wide grid system. As pointed out by R W Smith, General Manager of G.E.'s Transformer Div, a coast-to-coast power grid would see Chicago drawing power from Portland, Oregon every morning before the sun has risen in the Pacific Northwest, then paying it back the same evening. This in itself would mean better utilization of installed equipment through a stretch-out of high-load periods.

Although the philosophy of Power to grow . . . *electrically* has been built around the industrial electrical-distribution system, the same basic thinking is in evidence in the EHV set-up. In another light, you may look upon this move as a confirmation, on the part of the people and companies involved, that the years ahead will be power-growth years. G.E. calls this Project EHV, and considers it part of *Operation Upturn*, the company's broad program to accelerate business recovery by bringing all resources into action in the buy-now-for-better-values campaign.

THERMO REFRESHER NO. 20

By B G A SKROTZKI, Associate Editor




1 Diesel-cycle thermal efficiency equals Otto-cycle efficiency at unity cutoff ratio, but drops with increasing cutoff ratio

**Internal-combustion engine cycles can be tailored to meet many practical conditions. They all use a reciprocating piston in a cylinder to convert heat energy to shaft work. To burn distillate oils . . .**

# Diesel engines use compression ignition

We studied the processes of an Otto engine in Part 17, POWER, March 1958, pp 90-93. The *Diesel* engine, which we'll study now, has many similarities to the Otto engine, differing primarily in the way it receives heat energy.

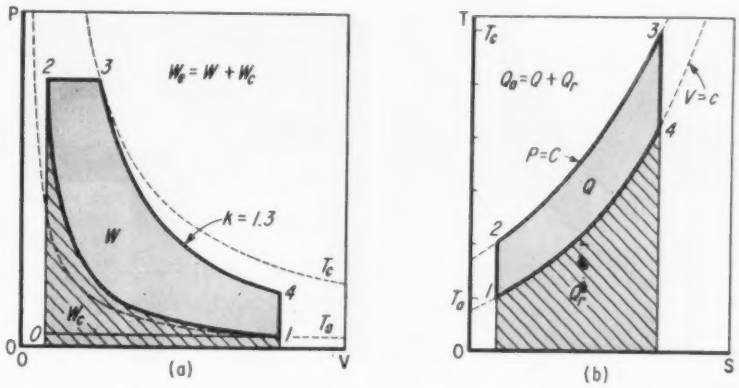
**Diesel cycle.** In Fig. 2 the induction stroke *0-1* inhales a charge of air into the cylinder. From *1* to *2* the piston compresses the air at constant-*S* so its temperature rises to a level high enough to ignite the distillate oil that fuels the engine. From *2* to *3* oil injected into the hot compressed air ignites and burns as it enters; at the same time the air and combustion products expand so their pressure stays constant. Since this is a constant-pressure process, the internal energy of the mixture of air and combustion products rises and simultaneously does work on piston.

During *3-4* the hot gases expand at constant-*S* doing work on the piston. At *4* the exhaust valve opens and most of the hot gases blow off to atmosphere until cylinder pressure drops to atmospheric at *1*. During the exhaust stoke *1-0* the piston pushes the remaining gases out of the cylinder; then engine starts its next cycle.

As with the Otto cycle we can analyze the ideal diesel cycle by assuming that one pound of air stays in the cylinder at all times. Then *2-3* is a simple constant-pressure heating process and *4-1* a constant-volume cooling process.

Heat $Q_a$ is added to the cycle during *2-3*, and heat $Q_r$ is rejected by the cycle during *4-1*. By the first Law the net shaft work output $W = Q = Q_a - Q_r$. By a parallel analysis the net shaft work $W = W_e - W_c$, the difference of the expansion work done on the piston and the compression work done by the piston. Fig. 2 shows these areas.

**Thermal efficiency** of the diesel cycle is one of our prime interests, so let's see what basic relationships we can develop. In Table 1 we derive equation (4) for the thermal ef-




2 Diesel-engine cycle resembles Otto cycle but differs in the heat-adding process by absorbing energy at constant pressure from state *2* to state *3* while doing shaft work

## 1—Diesel-cycle thermal efficiency depends on compression ratio and fuel-cutoff ratio

1. $Q_a = E_3 - E_2 + W_{23} = c_p(T_3 - T_2)$ (see Fig. 2)
2. $Q_r = E_4 - E_1 = c_v(T_4 - T_1)$
3. $W = Q_a - Q_r = c_p(T_3 - T_2) - c_v(T_4 - T_1)$
4. $e = \dfrac{W}{Q_a} = \dfrac{c_p(T_3 - T_2) - c_v(T_4 - T_1)}{c_p(T_3 - T_2)} = 1 - \dfrac{T_4 - T_1}{k(T_3 - T_2)}$

**For the constant-S processes:**

5. $T_2 = T_1\left(\dfrac{V_1}{V_2}\right)^{k-1} = T_1 V_r^{k-1}$
6. $T_4 = T_3\left(\dfrac{V_3}{V_4}\right)^{k-1}$

**For the constant-P process:**

7. $\dfrac{V_3}{V_2} = \dfrac{T_3}{T_2} = V_c$ (fuel-cutoff ratio by definition)
8. $T_3 = T_2 V_c$

**Substituting from (5):**

9. $T_3 = T_1 V_r^{k-1} V_c$

**Substituting in (6):**

10. $T_4 = T_1 V_r^{k-1} V_c\left(\dfrac{V_3}{V_4}\right)^{k-1}$

**But from (7):**

11. $V_3 = V_2 V_c$

**Substituting in (10) and noting $V_4 = V_1$:**

12. $T_4 = T_1 V_r^{k-1} V_c\left(\dfrac{V_2 V_c}{V_1}\right)^{k-1}$

$$= T_1 V_r^{k-1} V_c\left(\frac{V_c}{V_r}\right)^{k-1} = T_1 V_c^{k}$$

**Substituting for $T_2$, $T_3$ and $T_4$ in (4) from (5), (9) and (12):**

13. $e = 1 - \dfrac{T_1 V_c^{k} - T_1}{k(T_1 V_r^{k-1} V_c - T_1 V_r^{k-1})} =$

$$1 - \frac{V_c^{k} - 1}{k V_r^{k-1}(V_c - 1)} = 1 - \frac{1}{V_r^{k-1}}\left[\frac{V_c^{k} - 1}{k(V_c - 1)}\right]$$

ficiency in terms of the end process temperatures. As always, the average temperatures of heat addition and rejection control the thermal efficiency; the higher the upper average and the lower the lower average, the more efficient the cycle.

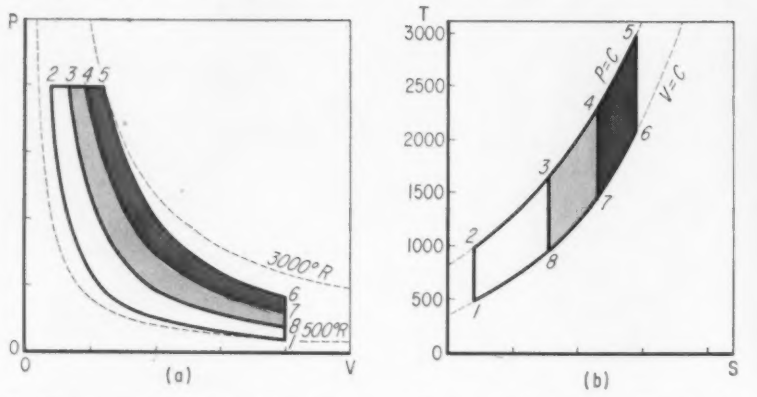
But as in the Otto cycle, these temperatures are controlled by the mechanical dimensions and ratios of the cylinder volume and piston displacement. Two ratios control in the diesel cycle; the compression ratio $V_r = V_1/V_2$ and the fuel-cutoff ratio $V_c = V_3/V_2$, see Fig. 2.

The derivation in Table 1 works up relations for all the temperatures $T_2$, $T_3$ and $T_4$ in terms of $T_1$ and the two volume ratios. This is done in equations (5), (9) and (12). Making these substitutions we find equation (13) that shows thermal efficiency of the theoretical diesel cycle depends only on the compression ratio, fuel-cutoff ratio and the ratio of specific heats $k$.

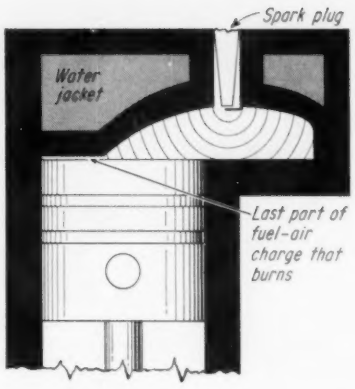
When the quantity in the bracket equals 1, the diesel efficiency equals the Otto efficiency. This happens when we have a cycle where at state *2* a minute amount of $Q_a$ is added. Then, expanding the gas to state *1*, we reject a minute amount of heat $Q_r$. The amount of work developed is practically zero, but it's produced at the best efficiency (Otto cycle) for the given compression ratio and practically unity fuel-cutoff ratio.

But as the fuel-cutoff ratio grows the efficiency at a given compression ratio drops. So we see that the diesel cycle has a lower efficiency than the Otto cycle for the same compression ratio. Fig. 1 shows how the diesel cycle thermal efficiency varies when $k = 1.3$. Thermal efficiency rises rapidly at low compression ratios, but above about 20 rate of rise tapers off. For increasing fuel-cutoff ratios the increment drop in efficiency decreases. In practical diesel engines the maximum cutoff ratios run about 2.5.

In Fig. 2*a* we can define another ratio called the expansion ratio, $V_e = V_4/V_3 = V_1/V_3$. The three ratios are then related as $V_e V_c = V_r$ since $(V_1/V_3)\ (V_3/V_2) = V_1/V_2$. To maintain high efficiency in a diesel engine the expansion ratio should be kept high and fuel-cutoff ratio low; this relation is automatic since their




**3** Work ouput of diesel cycle varies by controlling the amount of heat injection because a constant amount of air passes through cylinder regardless of engine load




**4** Cylinder-head shape helps to cool the last part of fuel-air charge to burn

product equals the compression ratio, a design factor of every engine.

**Load control** for the diesel cycle obviously depends on the fuel-cutoff ratio which depends on the amount of fuel injected. Fig. 3 shows how the net work output and top temperature varies with cutoff.

With cutoff at state *3*, the net work produced and heat converted are the areas *1-2-3-8*. For cutoff at state *4*, work and heat increase to areas *1-2-4-7*. Cutoff at state *5* raises work and heat to areas *1-2-5-6*. But as Fig. 1 shows, getting more work per cycle is done at the expense of lower thermal efficiency, since the compression ratio is constant in a given engine.

Delaying cutoff to obtain higher output also raises the top cycle temperature, as shown in Fig. 3*b*. This would seem to point to the possibility of higher thermal efficiency because this raises the *average* temperature at which $Q_a$ is injected into the cycle. But, unfortunately, the *average* temperature at which $Q_r$ is rejected from the cycle also rises, and at a faster rate than the temperature for $Q_a$. So we end up with an overall drop in cycle thermal efficiency.

**Supercharging.** We can supercharge a diesel-engine cylinder in the same way we do an Otto engine, see Part 19, POWER, May 1958, pp 88-91. As in the Otto engine we do not raise thermal efficiency by salvaging some of the available energy in the exhaust, but we do raise the work output yielded by a given cylinder and piston. Theoretically, we can get a large byproduct output of shaft work through an exhaust turbine for high supercharging ratios, and raise the thermal efficiency in this way.

**Preignition.** The smooth addition of $Q_a$ in the theoretical diesel and Otto cycles is a greatly simplified assumption of the actual way that heat develops in an engine cylinder. The spark-ignited Otto engine inhales a mixture of air and gasoline vapor and compresses it.

To prevent preignition of the fuel-air mixture the compression temperature must be kept below the ignition temperature. An electric spark ignites the mixture at or near the end of the compression stroke. To prevent preignition the engine's compression ratio must be kept below about 11 or 12. Modern auto engines have compression ratios ranging about 6 to 10; this limits the maximum efficiency at which an Otto engine can work.

In contrast to the Otto engine, the diesel engine depends on compressing the air enough to heat it to the ignition temperature of the fuel. Ideally, the fuel starts burning as soon as it mixes with the compressed air at the beginning of the constant-pressure process. To achieve ignition temperatures, Diesel engines must have compression ratios of at least 12. Practical diesel-engine compression ratios range from about 12 to 22.

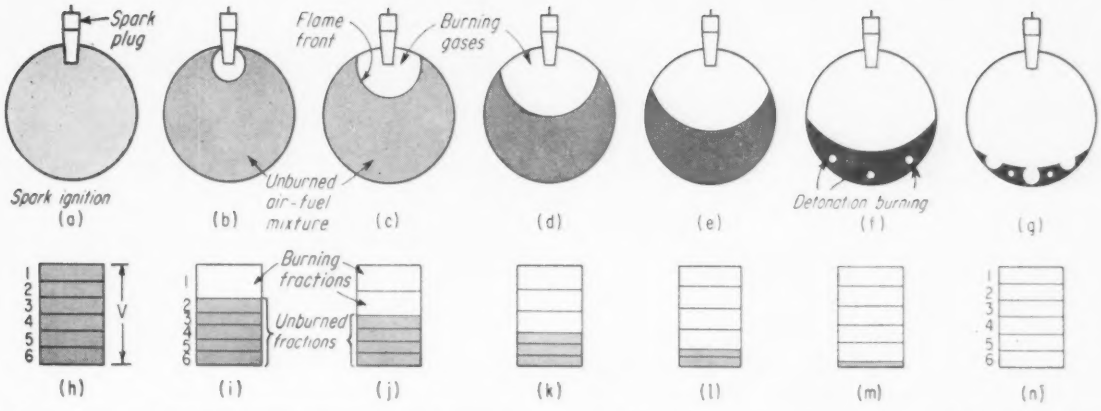
Because of the fuel-ignition limitations of the Otto engine and the low compression ratios that must be used, we find *actual* diesel *engines* more efficient than automotive Otto *engines*, despite the Otto *cycle* being more efficient than the diesel. The practical compression ratios for the engines explain the paradox.

**Otto detonation.** Spark-ignited gasoline-fired engines must be designed to avoid detonation or knocking—a phenomenon not anticipated in the simple Otto cycle. Fig. 5*a* to *g* shows schematically what takes place in the head end of the cylinder after compression when the fuel vapor burns in the compressed air.

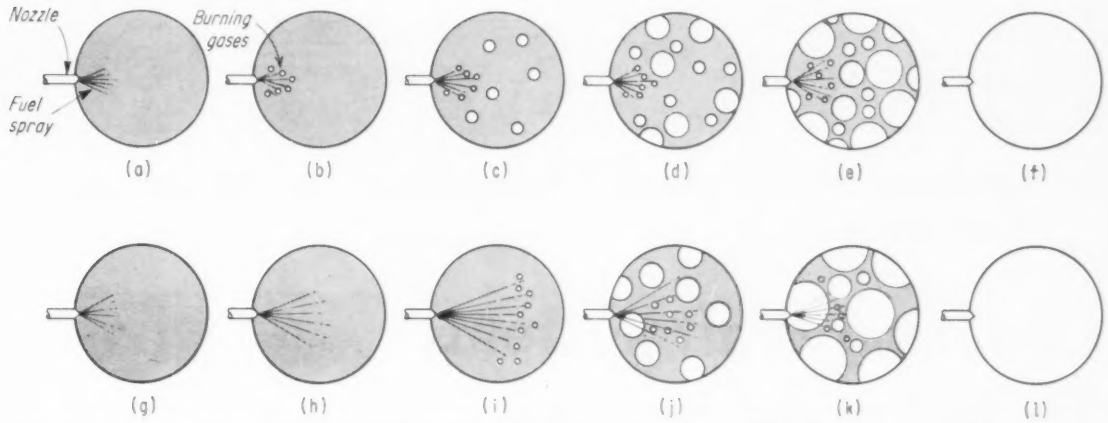
In *a*, the spark ignites the gasoline-air mixture surrounding it. In *b* through *e*, the flame front spreads more or less smoothly through the fuel-air mixture which burns rapidly as the flame front passes through. The sharp temperature rise of the combustion products quickly raises the pressure of both the burned and unburned parts of the fuel-air mixture.

This rise in pressure boosts the temperature of the unburned portion of the fuel-air mixture. This may be enough to ignite it before the flame front passes through. This causes an explosive rise in pressure (detonation) that strains the engine, causes audible knocking and produces local hot spots on the cylinder wall and piston face.

Fig. 5*h* to *n* shows the changes in volume of the different parts of the air-fuel mixture, and assumes that the total volume stays constant. As part *1* burns it expands and squeezes the other five unburned parts into a smaller volume, while the total volume stays constant. This raises both




**5** Looking down into Otto-engine cylinder during burning we see flame front moving uniformly through fuel-air mixture, *a* to *g*. Block graphs, *h* to *n*, show that last part of the charge to burn, *6*, is highly compressed into small volume and may cause knocking




**6** Looking down into diesel-engine cylinder during burning, *a* to *f*, we see fuel spray igniting right after it mixes with turbulent air to burn at uniform rate. In *g* to *l* delayed ignition of fuel causes explosive pressure rise because of accumulated fuel

pressure and temperature of the unburned parts. As additional parts burn the remaining unburned fractions continue rising in temperature and pressure. The last fraction, *6*, experiences the highest pressure and temperature rise of all. As we said, if temperature exceeds ignition level, this fraction burns explosively.

This shows that detonation in a gasoline engine develops from the uncontrolled burning of the last part of the fuel-air charge. We can prevent this if we find ways of keeping the compression temperature of the last unburned part somewhere below its ignition temperature.

We use two ways. One consists of designing the cylinder head so the last part of the charge spreads itself thinly over a cool heat-transfer surface, Fig. 4. This cools the last fraction enough to prevent it detonating and allows the flame front to move through it smoothly so the cylinder pressure rises steadily without abrupt surge.

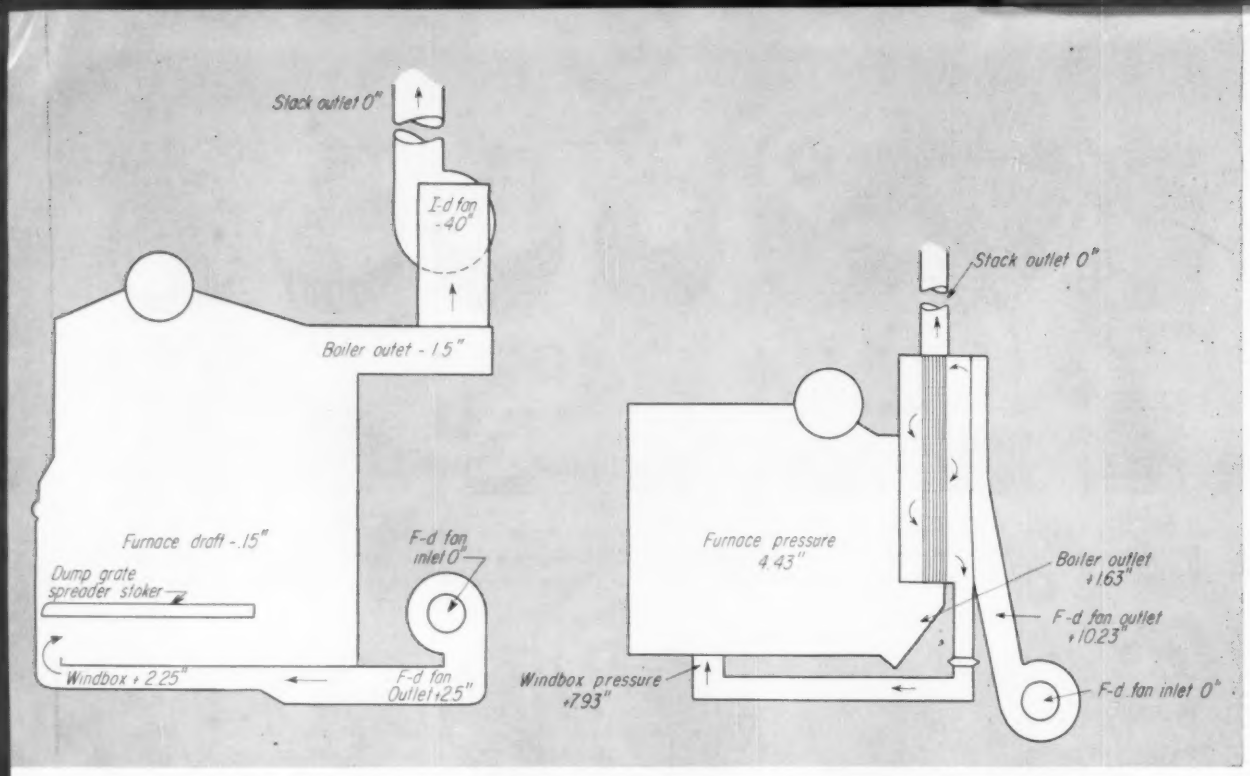
The other method consists of treating gasoline to raise its ignition level. This characteristic is measured by an arbitrary scale of "octane rating." Higher octane-number gasolines are less likely to detonate. Both methods are ordinarily used to control detonation. Higher compression engines need higher octane gasolines.

**Diesel detonation.** Diesel engines also have knocking troubles, but for a reason different than for Otto engines. Fig. *6a* to *f* shows schematically the burning procedure at constant pressure in the cylinder head as we look down into it. Pistons and cylinder heads of diesel engines usually have special shapes to promote turbulent motion of the air when it's compressed—not shown in Fig. 6.

In *6a* the fuel has just begun to spray into the turbulent high-temperature high-pressure air; in *b* some fuel-air mixture "cells" start burning. In *c* the turbulence has carried these growing cells into other parts of the cylinder, but new burning cells keep forming at the nozzle as more fuel sprays into the cylinder.

This action produces uniform burning rate at constant pressure until all fuel is consumed at *f*. The action depends on prompt ignition of the fuel as it enters the hot air; fuel must have low-enough ignition temperature.

(*Continued on page* 158)




**Balanced-draft or pressurized furnace? Here are pros and cons to be considered in . . .**

# Choosing draft systems for industrial boilers

By H G MEISSNER
Combustion Engineering, Inc

Pressurized-furnace watertube boilers for firing gas and oil appear to be advancing in popularity. And there's a definite trend toward such furnace design for firing solid fuels. Actually, a number of the small firetube-boiler designs have employed the pressurized furnace for years. But watertube-boiler design doesn't lend itself as easily to this concept as does its internally-fired cousin.

Initially, emphasis on development of the pressurized-furnace watertube steam generator was probably greater in central-station unit design. However, the industrial boiler remained very much in mind and it's in this field that the pressurized furnace is making itself known.

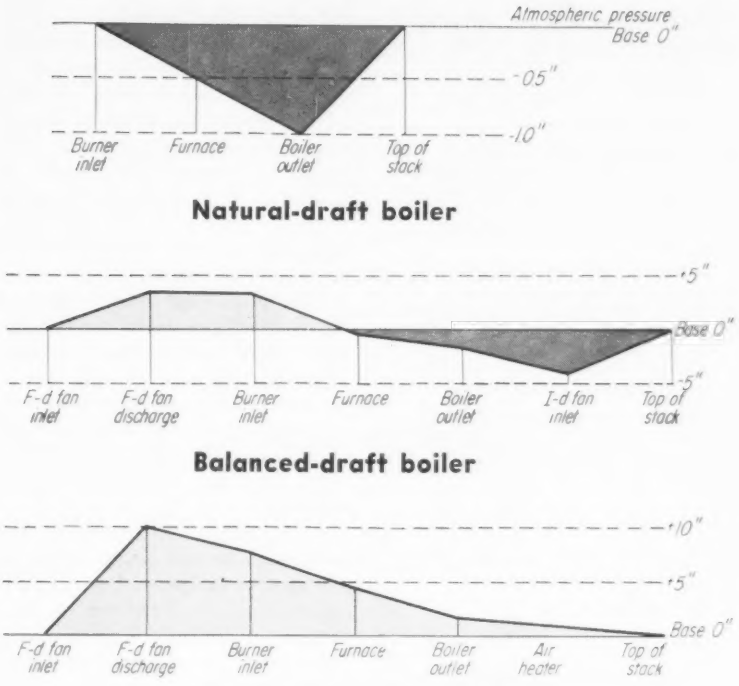
Basic function of any draft-producing equipment is to supply energy necessary to maintain required air and gas flow through the system. Before discussing relative merits of systems in general use to provide this flow, let's touch briefly on the fundamentals of draft.

**Density differential** of two connected columns of air results in a pressure differential which causes what we term *draft*. In the same vein, this pressure differential creates *stack effect*. Degree of stack effect (chimney draft) depends on stack's height and its internal gas temperature. It's a negative pressure (below atmospheric) and, in expression, it's preceded by a minus sign. If we place a fan in front of the system to produce desired air and gas flow, we refer to it as *forced draft*. Static pressure at a forced-draft fan's outlet is above atmospheric and its expression is preceded by a plus sign. Thus, draft may be either static or dynamic, but the final result causes the air or gas to flow as desired.

Natural draft may be assisted, or supplanted by a fan located at the system outlet. We refer to this as *induced draft*. Thus, a natural- or induced-draft furnace is one in which air-pressure drop through fuel bed or burner, and the draft loss through the boiler, are overcome by the negative pressure or "suction" of the chimney or induced-draft fan respectively. Most of the old hand-fired coal-burning boilers were equipped with natural-draft stacks, occasionally assisted by i-d fans.

**Balanced-draft furnaces** have a f-d fan to provide the static pressure needed to push the combustion air through the fuel bed or burner, while the stack or i-d fan overcomes draft loss through the boiler and heat-recovery equipment. The two fans are regulated to produce a slight negative pressure in the furnace. With installation of an air heater, economizer or dust collector, an i-d fan is almost

## Though different in the middle, all boiler draft pressures are same at ends




Theoretically all boiler-draft systems begin with inlet air at atmospheric pressure and end with outlet gases at atmospheric pressure. And this is generally true from a practical standpoint.

However, there's a big difference in pressures from system to system at various points in each system. Curves, *left*, show natural-draft-furnace pressure at minus 1-in. Pressure return to atmospheric is due to stack's "suction pump" action.

In a balanced-draft boiler, f-d fan boosts pressure above atmospheric through burner. Pressure drop occurs through furnace and boiler outlet. I-d fan picks up failing draft and hauls it back to base pressure at stack's top. Note that in both cases, furnace pressure is in the negative range.

Pressurized unit, however, keeps system above atmospheric pressure from start to finish.

---

always necessary because of added draft loss through such equipment.

**Pressurized furnaces** (actually *pressure-fired* furnaces) require only f-d fans. These furnish the static pressure needed to force the air through air heater, ducts and burners; they also overcome draft loss through the boiler, gas ducts, air heater and dust collector, when used—all of which are held above atmospheric pressure. It's interesting to note that static-discharge pressure at the fan discharge may range from, say, 8 to 10 in. water for small stationary boilers with air heater to 175 in. for naval boilers.

The pressurized-firing concept, with entire furnace, boiler and heat-recovery equipment under positive instead of negative pressure, is by no means new. Seagoing installations have been using it since the Howden system was developed before the turn of the century. Only difference is that this system pressurized the entire boiler room, whereas today we confine pressurizing to the interior casing of the windbox, furnace and boiler.

With the Howden system, it was possible to fire coal by hand or with stokers since any leakage through furnace or doors was into the boiler. Such firing isn't possible with modern pressurized firing, at least in its present development, because internal pressure is above that in the boiler room. Entire setting must be airtight which precludes use of conventional access, cleanout and observation doors.

Since changeover from coal to oil firing after World War I, marine boilers have almost universally adopted pressurized firing, because eliminating the i-d fan meant material savings in space, weight and power. In stationary plants—where need for space conservation is less urgent—the shift from natural or balanced draft has been at a much slower pace. Doubtless, many stationary boilers will, for years to come, burn solid fuels on mechanical stokers.

Pressurized-firing application area is quite well defined, as it depends largely on fuels such as oil and gas or combinations of both. Boilers fired in this manner are available from the small packaged sizes designed to deliver a few thousand pounds of steam per hour, up to larger standardized designs which will produce as much as 200,000 lb steam per hr for industrial power and process loads.

**Other applications** are: (1) Large high-pressure industrial and utility steam generators; for these larger plants, fan power savings in eliminating the i-d fan are appreciable. Too, resultant lower center of gravity may simplify wind and earthquake bracing problems. (2) Waste-heat boilers, which frequently handle gas with entrained solids, are generally pressurized to avoid i-d fan erosion. (3) CO boilers, now used extensively in oil refineries, are always pressurized. Large gas volume involved for the low Btu fuel would make an i-d fan impractical. (4) Boilers designed for high-pressure hot-water systems.

The pressurized furnace must be completely water cooled, usually with tangent or fin tubes. Tangent tubes

## Comparison of balanced-draft vs pressurized-furnace firing

| Balanced draft | Pressurized furnace |
|---|---|
| Any fuel—solid, liquid, gas—and all types of stokers | Limited to oil, gas, pulverized coal, waste heat and CO boilers |
| Setting may be refractory or waterwall, with or without steel casing | Requires full waterwall furnace and higher-cost gastight casing |
| Generally requires both forced- and induced-draft fans, except for low-capacity units with no heat recovery. Fan's first cost and power consumption about double that for one f-d fan | Needs forced-draft fan only with static pressure sufficient to overcome all pressure losses. Fan power about 60% and first cost about 40% of that for 2-fan layout |
| Boiler and setting generally field-erected with little or no subassembly | Boiler and setting may be partly or wholly shop-assembled |
| Greater steel weight for i-d fan may increase first cost and erection. Fan also involves expensive wiring, added combustion controls | Reduced erection cost and less vibration without i-d fan. Lower cost for electrical wiring and controls. Simpler operation, controls |
| Easier access to furnace for repair and cleaning | Soot blowers must do all cleaning. Access may require burner removal |

must be swaged or offset where they enter the headers and drums, at added cost. The steel casing must be either well insulated to avoid overheating and expansion difficulty, or be of either the double-wall or skin-cased design. In the double wall, used largely in naval boilers, the forced draft is carried between the two shells which may extend entirely around the boiler, or over burner section only.

In the skin-cased boiler, the inner steel shell is welded to and expands with the tubes. The outer casing is at approximately air temperature and can be welded tight without expansion joints. In either case, furnace maintenance is negligible. Modern waterwall furnaces are generally designed to withstand internal pressure of up to 40 psi, to avoid being damaged by a furnace puff. Consequently, they're well able to handle pressurized firing's few pounds pressure or less.

**Balanced-draft firing,** on the other hand, is very flexible in its application. It's used for burning almost every variety of liquid, gaseous and solid fuel. Boiler setting may comprise anything from solid refractory to air-cooled suspended walls. Or, it may be refractory, insulation and outer casing combinations. In many cases the setting may be furnished partly or wholly by the purchaser from local sources. This is highly desirable in some cases. Example: If great distances or an export job is involved, the purchaser saves much in transportation or import costs. Field erection time may be greater, but lower-cost local labor often compensates for this. In some cases the purchaser might furnish everything but the boiler's pressure parts, air heaters, firing equipment and fans.

Seasonal-nature industries usually have relatively long idle periods in which necessary refractory or other furnace repairs may be made without affecting plant production. In such plants the almost total absence of maintenance requirements of the pressurized furnace is of less value than in a plant which must produce steam throughout the entire year.

**Pulverized-coal firing** with pressurized furnaces is in the preliminary stage today. There are few actual installations, though they're being seriously considered in increasing numbers for proposed installations. Developments in this field during the next few years should prove interesting.

With stoker-fired solid fuels, the pressurized furnace isn't practical at this stage of the game. Furnace sealing, when cleaning or inspecting fires, hasn't been solved. With traveling grate and continuous discharge spreader stokers, which require little or no manual attention, the problem isn't too difficult and will be solved in time. But with other stokers, such as dump grate spreaders and single- or multiple-retort underfeeds, there is no foreseeable application of the pressurized furnace.

From a fan power and maintenance standpoint, pressurized firing has the edge on balanced-draft systems. It's well known that the i-d fan is by far the more troublesome as well as the more expensive when compared with the f-d fan. The i-d fan is bigger (more power), and its maintenance can be a serious factor. It is apt to operate at high temperature and frequently handles corrosive and dust-laden gases. In many cases it must be spotted on top of the boiler or air heater, requiring heavy steelwork for its support. As fan blades become coated with soot from improperly adjusted oil burners, or eroded by flyash from coal-fired units, they may become unbalanced, setting up vibration problems which are aggravated by their awkward location. Under such conditions the advantage of getting rid of the i-d fan is obvious—provided we don't introduce disadvantages in the process.

**Fan power** comparison between

(*Continued on page* 154)

Perforated for your filing ease

# Power's data sheet

No. 311

## Alloy-steel pipe to ASTM Spec A-335 Grade P-22 (2¼ Cr-1 Mo)

| Pipe Size In. | Nom. OD In. | Wall Thick In. | Temperature—F: To 800 | 850 | 900 | 950 | 1000 | 1050 | 1100 |
|---|---|---|---|---|---|---|---|---|---|
| | | | Maximum Allowable Stress—PSI: 15,000 | 14,400 | 13,100 | 11,000 | 7800 | 5800 | 4200 |
| **Schedule 10** | | | | | | | | | |
| 14 | 14 | .250 | 330 | 317 | 288 | 245 | 174 | 130 | 94 |
| 16 | 16 | .250 | 291 | 279 | 254 | 214 | 152 | 113 | 82 |
| 18 | 18 | .250 | 255 | 245 | 223 | 190 | 135 | 100 | 72 |
| 20 | 20 | .250 | 233 | 223 | 203 | 171 | 121 | 90 | 65 |
| 24 | 24 | .250 | 195 | 187 | 170 | 143 | 101 | 75 | 54 |
| **Schedule 20** | | | | | | | | | |
| 8 | 8.625 | .250 | 540 | 518 | 471 | 400 | 285 | 212 | 154 |
| 10 | 10.75 | .250 | 435 | 418 | 380 | 319 | 228 | 170 | 123 |
| 12 | 12.75 | .250 | 366 | 351 | 320 | 269 | 192 | 143 | 103 |
| 14 | 14 | .312 | 450 | 432 | 393 | 332 | 237 | 176 | 128 |
| 16 | 16 | .312 | 395 | 374 | 341 | 290 | 207 | 154 | 111 |
| 18 | 18 | .312 | 350 | 331 | 301 | 257 | 183 | 136 | 99 |
| 20 | 20 | .375 | 399 | 389 | 353 | 293 | 210 | 156 | 113 |
| 24 | 24 | .375 | 330 | 317 | 288 | 244 | 174 | 129 | 92 |
| **Schedule 30** | | | | | | | | | |
| 8 | 8.625 | .277 | 630 | 605 | 550 | 462 | 329 | 245 | 176 |
| 10 | 10.75 | .307 | 578 | 554 | 504 | 425 | 304 | 226 | 164 |
| 12 | 12.75 | .330 | 534 | 518 | 471 | 393 | 281 | 209 | 151 |
| 14 | 14 | .375 | 570 | 547 | 498 | 421 | 301 | 224 | 162 |
| 16 | 16 | .375 | 495 | 475 | 432 | 368 | 262 | 195 | 141 |
| 18 | 18 | .438 | 540 | 518 | 471 | 394 | 281 | 209 | 151 |
| 20 | 20 | .500 | 570 | 547 | 498 | 418 | 299 | 222 | 161 |
| 24 | 24 | .562 | 540 | 518 | 471 | 399 | 285 | 212 | 153 |
| **Schedule 40** | | | | | | | | | |
| ½ | .84 | .109 | 1695 | 1627 | 1480 | 1256 | 911 | 678 | 491 |
| ¾ | 1.05 | .113 | 1455 | 1397 | 1271 | 1074 | 777 | 578 | 418 |
| 1 | 1.315 | .133 | 1569 | 1506 | 1370 | 1163 | 812 | 626 | 454 |
| 1¼ | 1.66 | .14 | 1059 | 1017 | 930 | 781 | 563 | 418 | 303 |
| 1½ | 1.90 | .145 | 1005 | 965 | 877 | 742 | 533 | 397 | 287 |
| 2 | 2.375 | .154 | 906 | 870 | 791 | 668 | 480 | 357 | 258 |
| 2½ | 2.875 | .203 | 1215 | 1166 | 1061 | 899 | 648 | 482 | 349 |
| 3 | 3.50 | .216 | 1095 | 1051 | 956 | 808 | 581 | 432 | 313 |
| 4 | 4.50 | .237 | 975 | 936 | 851 | 717 | 515 | 383 | 278 |
| 5 | 5.563 | .258 | 885 | 850 | 773 | 656 | 471 | 350 | 254 |
| 6 | 6.625 | .28 | 833 | 799 | 727 | 614 | 440 | 327 | 237 |
| 8 | 8.625 | .322 | 771 | 740 | 668 | 568 | 407 | 303 | 219 |
| 10 | 10.75 | .365 | 720 | 691 | 628 | 533 | 381 | 284 | 205 |
| 12 | 12.75 | .406 | 690 | 662 | 603 | 512 | 366 | 272 | 197 |
| 14 | 14 | .438 | 690 | 662 | 603 | 509 | 365 | 271 | 196 |
| 16 | 16 | .50 | 713 | 684 | 622 | 525 | 376 | 279 | 202 |
| 18 | 18 | .562 | 726 | 697 | 634 | 535 | 383 | 285 | 206 |
| 20 | 20 | .593 | 690 | 662 | 603 | 511 | 365 | 272 | 197 |
| 24 | 24 | .687 | 683 | 655 | 596 | 503 | 360 | 268 | 194 |
| **Schedule 60** | | | | | | | | | |
| 8 | 8.625 | .406 | 1035 | 994 | 904 | 765 | 550 | 409 | 296 |
| 10 | 10.75 | .50 | 1071 | 1028 | 930 | 791 | 569 | 423 | 306 |
| 12 | 12.75 | .562 | 1035 | 994 | 904 | 762 | 548 | 407 | 295 |
| 14 | 14 | .593 | 999 | 959 | 877 | 737 | 530 | 394 | 285 |
| 16 | 16 | .656 | 975 | 936 | 851 | 723 | 520 | 386 | 280 |
| 18 | 18 | .750 | 1011 | 971 | 883 | 746 | 537 | 399 | 289 |
| 20 | 20 | .812 | 990 | 950 | 864 | 733 | 527 | 392 | 284 |
| 24 | 24 | .968 | 1005 | 965 | 877 | 774 | 557 | 414 | 300 |
| **Schedule 80** | | | | | | | | | |
| ½ | .84 | .147 | 3036 | 2915 | 2646 | 2272 | 1681 | 1250 | 905 |
| ¾ | 1.05 | .154 | 2589 | 2485 | 2261 | 1932 | 1420 | 1056 | 765 |
| 1 | 1.315 | .179 | 2612 | 2507 | 2281 | 1949 | 1433 | 1065 | 772 |
| 1¼ | 1.66 | .191 | 1935 | 1857 | 1690 | 1441 | 1049 | 780 | 565 |
| 1½ | 1.90 | .20 | 1821 | 1748 | 1585 | 1352 | 983 | 731 | 529 |
| 2 | 2.375 | .218 | 1665 | 1596 | 1454 | 1232 | 894 | 665 | 481 |
| 2½ | 2.875 | .276 | 1943 | 1865 | 1696 | 1443 | 1051 | 781 | 566 |
| 3 | 3.50 | .30 | 1770 | 1699 | 1545 | 1312 | 953 | 709 | 513 |
| 4 | 4.50 | .337 | 1599 | 1540 | 1401 | 1185 | 859 | 639 | 463 |
| 5 | 5.563 | .375 | 1470 | 1411 | 1283 | 1092 | 790 | 587 | 425 |
| 6 | 6.625 | .432 | 1470 | 1411 | 1283 | 1091 | 789 | 587 | 425 |
| 8 | 8.625 | .50 | 1344 | 1290 | 1174 | 995 | 718 | 534 | 387 |
| 10 | 10.75 | .593 | 1311 | 1259 | 1140 | 970 | 700 | 521 | 377 |
| 12 | 12.75 | .687 | 1305 | 1252 | 1140 | 965 | 697 | 518 | 375 |
| 14 | 14 | .75 | 1311 | 1259 | 1140 | 970 | 700 | 521 | 377 |
| 16 | 16 | .843 | 1305 | 1252 | 1140 | 967 | 698 | 519 | 376 |
| 18 | 18 | .937 | 1305 | 1252 | 1140 | 963 | 695 | 517 | 374 |
| 20 | 20 | 1.031 | 1129 | 1252 | 1134 | 961 | 693 | 516 | 373 |
| 24 | 24 | 1.218 | 1290 | 1238 | 1127 | 958 | 691 | 514 | 372 |

| Pipe Size In. | Nom. OD In. | Wall Thick In. | Temperature—F: To 800 | 850 | 900 | 950 | 1000 | 1050 | 1100 |
|---|---|---|---|---|---|---|---|---|---|
| | | | Maximum Allowable Stress—PSI: 15,000 | 14,400 | 13,100 | 11,000 | 7800 | 5800 | 4200 |
| **Schedule 100** | | | | | | | | | |
| 8 | 8.625 | .593 | 1650 | 1584 | 1441 | 1222 | 886 | 659 | 477 |
| 10 | 10.75 | .718 | 1635 | 1569 | 1428 | 1216 | 881 | 655 | 475 |
| 12 | 12.75 | .843 | 1650 | 1584 | 1441 | 1226 | 889 | 661 | 479 |
| 14 | 14 | .937 | 1695 | 1627 | 1480 | 1254 | 910 | 677 | 490 |
| 16 | 16 | 1.031 | 1635 | 1569 | 1428 | 1214 | 881 | 655 | 474 |
| 18 | 18 | 1.156 | 1650 | 1584 | 1441 | 1221 | 886 | 659 | 477 |
| 20 | 20 | 1.281 | 1650 | 1584 | 1441 | 1227 | 890 | 662 | 479 |
| 24 | 24 | 1.531 | 1665 | 1598 | 1454 | 1235 | 896 | 666 | 482 |
| **XX** | | | | | | | | | |
| ½ | .84 | .294 | 9222 | 8853 | 8054 | 7206 | 5880 | 4372 | 3166 |
| ¾ | 1.05 | .308 | 7532 | 7230 | 6578 | 5815 | 4611 | 3429 | 2483 |
| 1 | 1.315 | .358 | 7140 | 6854 | 6236 | 5498 | 4331 | 3221 | 2332 |
| 1¼ | 1.66 | .382 | 5580 | 5357 | 4873 | 4250 | 3266 | 2429 | 1759 |
| 1½ | 1.90 | .400 | 5115 | 4910 | 4467 | 3883 | 2963 | 2203 | 1595 |
| 2 | 2.375 | .436 | 4485 | 4306 | 3917 | 3390 | 2562 | 1905 | 1380 |
| 2½ | 2.875 | .552 | 4935 | 4738 | 4310 | 3742 | 2847 | 2117 | 1533 |
| 3 | 3.50 | .600 | 4410 | 4234 | 3851 | 3332 | 2515 | 1870 | 1354 |
| 4 | 4.50 | .674 | 3855 | 3701 | 3367 | 2902 | 2172 | 1615 | 1170 |
| 5 | 5.563 | .750 | 3480 | 3341 | 3039 | 2613 | 1945 | 1446 | 1047 |
| 6 | 6.625 | .864 | 3420 | 3283 | 2987 | 2566 | 1909 | 1419 | 1028 |
| 8 | 8.625 | .875 | 2609 | 2504 | 2278 | 1947 | 1431 | 1064 | 771 |
| **Schedule 120** | | | | | | | | | |
| 4 | 4.50 | .438 | 2235 | 2145 | 1951 | 1667 | 1219 | 907 | 656 |
| 5 | 5.563 | .50 | 2130 | 2045 | 1860 | 1581 | 1154 | 858 | 622 |
| 6 | 6.625 | .562 | 2040 | 1958 | 1781 | 1515 | 1105 | 822 | 595 |
| 8 | 8.625 | .718 | 2070 | 1987 | 1808 | 1536 | 1120 | 833 | 603 |
| 10 | 10.75 | .843 | 1980 | 1900 | 1729 | 1469 | 1070 | 796 | 576 |
| 12 | 12.75 | 1.00 | 2010 | 1930 | 1755 | 1493 | 1088 | 809 | 586 |
| 14 | 14 | 1.093 | 2010 | 1930 | 1755 | 1495 | 1090 | 810 | 587 |
| 16 | 16 | 1.218 | 1980 | 1900 | 1729 | 1468 | 1069 | 795 | 576 |
| 18 | 18 | 1.375 | 1995 | 1915 | 1742 | 1485 | 1082 | 805 | 583 |
| 20 | 20 | 1.50 | 1965 | 1886 | 1716 | 1462 | 1065 | 792 | 574 |
| 24 | 24 | 1.812 | 2003 | 1922 | 1749 | 1488 | 1085 | 807 | 584 |
| **Schedule 140** | | | | | | | | | |
| 8 | 8.625 | .812 | 2385 | 2290 | 2083 | 1778 | 1303 | 969 | 702 |
| 10 | 10.75 | 1.00 | 2406 | 2310 | 2096 | 1793 | 1314 | 977 | 708 |
| 12 | 12.75 | 1.125 | 2295 | 2203 | 2004 | 1709 | 1251 | 930 | 674 |
| 14 | 14 | 1.250 | 2340 | 2246 | 2043 | 1745 | 1278 | 951 | 688 |
| 16 | 16 | 1.438 | 2376 | 2281 | 2070 | 1770 | 1297 | 965 | 698 |
| 18 | 18 | 1.562 | 2304 | 2212 | 2017 | 1716 | 1256 | 934 | 676 |
| 20 | 20 | 1.75 | 2340 | 2246 | 2043 | 1740 | 1274 | 947 | 686 |
| 24 | 24 | 2.062 | 2310 | 2218 | 2017 | 1718 | 1258 | 935 | 677 |
| **Schedule 160** | | | | | | | | | |
| ½ | .84 | .187 | 4545 | 4363 | 3969 | 3441 | 2603 | 1935 | 1401 |
| ¾ | 1.05 | .218 | 4500 | 4320 | 3930 | 3404 | 2573 | 1913 | 1386 |
| 1 | 1.315 | .25 | 4296 | 4124 | 3752 | 3243 | 2444 | 1817 | 1316 |
| 1¼ | 1.66 | .25 | 3006 | 2886 | 2620 | 2249 | 1663 | 1237 | 896 |
| 1½ | 1.90 | .281 | 3090 | 2971 | 2698 | 2317 | 1715 | 1275 | 924 |
| 2 | 2.375 | .343 | 3225 | 3096 | 2816 | 2417 | 1793 | 1333 | 965 |
| 2½ | 2.875 | .375 | 2961 | 2843 | 2586 | 2215 | 1637 | 1217 | 881 |
| 3 | 3.50 | .438 | 2930 | 2812 | 2558 | 2191 | 1618 | 1203 | 871 |
| 4 | 4.50 | .531 | 2865 | 2750 | 2502 | 2146 | 1584 | 1178 | 853 |
| 5 | 5.563 | .625 | 2790 | 2679 | 2436 | 2087 | 1538 | 1144 | 828 |
| 6 | 6.625 | .718 | 2730 | 2621 | 2384 | 2043 | 1504 | 1119 | 810 |
| 8 | 8.625 | .906 | 2715 | 2605 | 2371 | 2028 | 1493 | 1110 | 804 |
| 10 | 10.75 | 1.125 | 2753 | 2642 | 2404 | 2056 | 1515 | 1126 | 816 |
| 12 | 12.75 | 1.312 | 2730 | 2621 | 2384 | 2043 | 1504 | 1119 | 810 |
| 14 | 14 | 1.406 | 2670 | 2563 | 2332 | 1997 | 1469 | 1093 | 791 |
| 16 | 16 | 1.593 | 2670 | 2563 | 2332 | 1992 | 1466 | 1090 | 789 |
| 18 | 18 | 1.781 | 2670 | 2563 | 2332 | 1990 | 1464 | 1089 | 788 |
| 20 | 20 | 1.968 | 2663 | 2556 | 2325 | 1988 | 1462 | 1087 | 787 |
| 24 | 24 | 2.343 | 2655 | 2550 | 2318 | 1983 | 1459 | 1085 | 786 |

### Maximum allowable working pressures—6

Figures in table give maximum psi pressures for given temperatures and stresses. See February *Data Sheet* 306 for basic formula from which table was calculated.

GEORGE C HALZELL, *Boston, Mass.*

CORRECTION: Head for June *Data Sheet* 310 should read—
"Alloy steel pipe to ASTM Spec A-335 Grade P-11 (1¼ Cr-½ Mo)"

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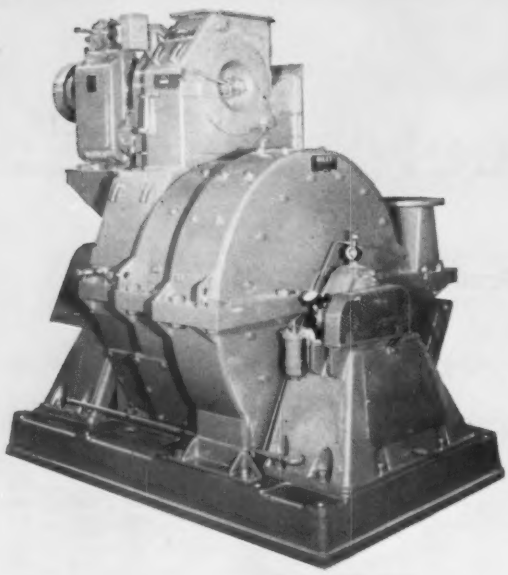
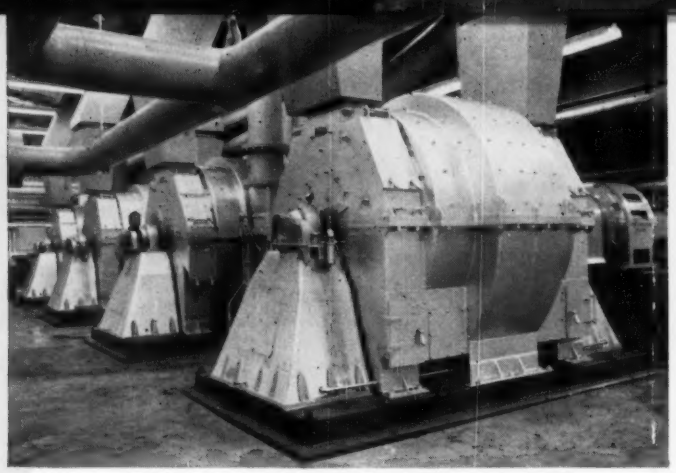


Latest model Riley #350 Pulverizer with Metering Coal Feeder which has a magnetic separator to remove metals escaping the conveyor magnets.



Four Riley 550 Duplex Pulverizers installed in the Picway Station of Columbus & Southern Ohio Electric Co. — one of the many Public Utilities that are using Riley Pulverizers.

# The Quiet, Vibrationless RILEY PULVERIZER is

## You will not only appreciate its quiet, vibrationless operation but ALL OF THESE OTHER ADVANTAGES:

### Dependability

Riley "50" Series Pulverizers are rugged in construction, simple in design concept. All moving parts are on a single shaft rotating on two main bearings. They require no worm gears or other complicated mechanisms. A high degree of selectivity of rejection of foreign material prevents damage to pulverizer parts.

### Sustained High Fineness

Tungsten Carbide faced pulverizing elements last for years providing a high degree of pulverized coal fineness.

### No Loss of Capacity With Wet Coals

Flash drying in crusher-dryer section evaporates all free moisture. Coal can be dripping wet when entering feeders without loss of capacity. Adequate primary air temperature is provided.

### Extreme Load Ranges

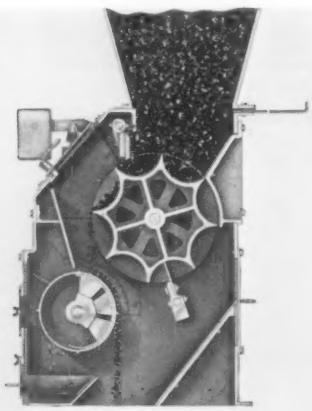
There is no lag with Riley Pulverizers to conform to load changes. Change in feeder rate gives instantaneous change in pulverized coal output.

### No Adjustment Necessary to Maintain Fineness

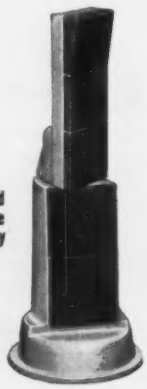
Riley Pulverizers need no springs or other wear conpensating devices which require shutdown for adjustment.

### A Minimum Labor Cost in Removing Rejections

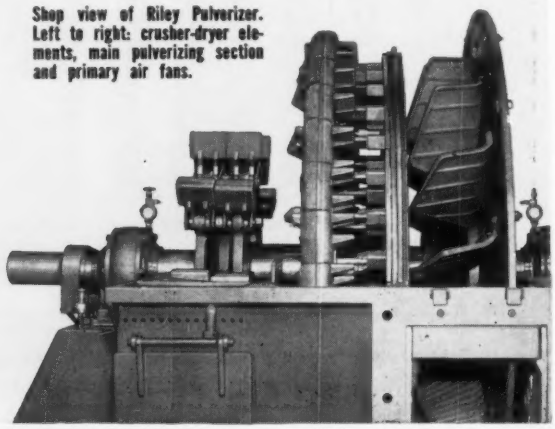
Tramp metal and other foreign materials are easily removed thru a door in the crusher-dryer section and thru one in the feeder.



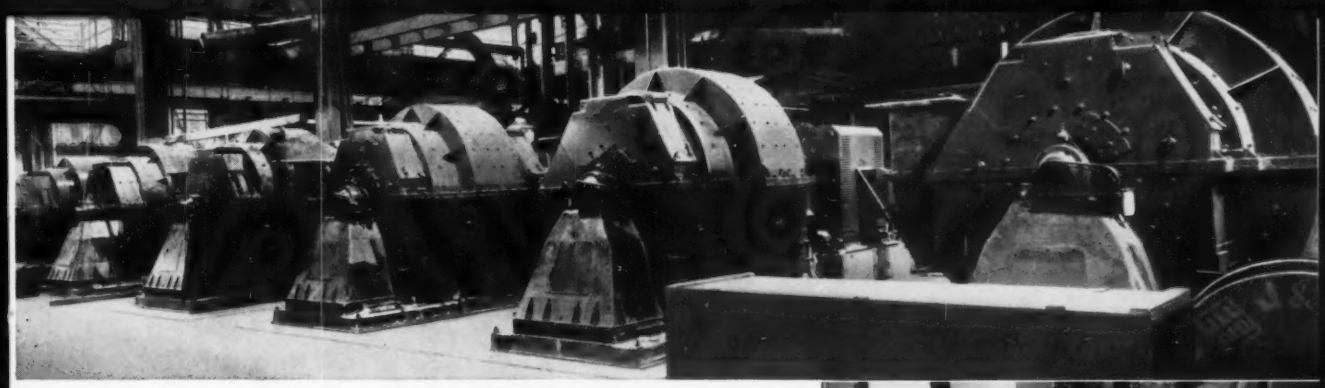
Cross section of Riley Feeder shows how coal is metered and the new magnetic separator.



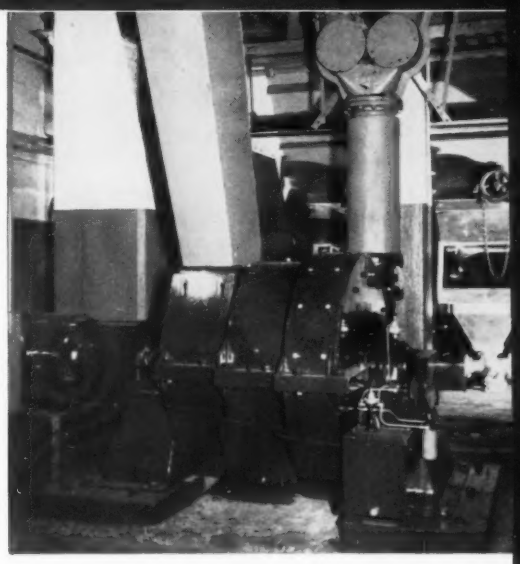
A tungsten carbide faced pulverizing element. Note how carbide completely protects the base.



Shop view of Riley Pulverizer. Left to right: crusher-dryer elements, main pulverizing section and primary air fans.



These six Riley Duplex Pulverizers will supply a 2,000,000 lbs/hr reheat unit at the River Rouge Plant of Detroit Edison Company.



A small #350 Riley Pulverizer installation, typical of hundreds that are operating in industrial power plants with units ranging in capacity from 50,000 lbs/hr up.

# Easy on the Nerves!

## Ease of Maintenance

All Pulverizer parts are accessible by simply removing top half of housing. Complete replacement of parts can be made in one day. Crusher-dryer parts can be replaced by merely removing separate covers in housing. Bearings for main shaft are only parts to be lubricated.

## Ability To Run Without Coal

Because no moving parts are in contact with each other, no damage will occur when operating without coal. Operation is quiet.

## Explosion Proof

There has never been an explosion in a Riley Pulverizer under normal operating conditions. Coal travels so fast thru pulverizer that flame can't propagate.

## High Primary Air Temperatures Used

Riley Pulverizers operate with discharge temperature normally at 200 F which increases boiler efficiency. Higher temperature aids combustion and lighting of burners.

## Ease of Automatic Regulation

Only two adjustments are needed with change of load; (1) coal feed to pulverizer and, (2) air to burners — ideal for efficient automatic operation.

## No Auxiliary Air for Sealing

Auxiliary blowers for sealing or for protection of bearings are not required.

## Compact and Space Saving Design

Riley Pulverizers occupy the least space per ton capacity of any pulverizer made.

## Low Foundation Cost

With no inherent vibration and being the lightest in weight per ton capacity, the foundation does not need to be massive and deep.

## Low Power Consumption

Due to the principle of pulverizing in suspension by impact and attrition, power to run Riley Pulverizers is low at all loads.

## Ease of Start-Up

The small percentage of primary air, and a uniform distribution of coal from Riley Burners make lighting of burners easy and provide a stable flame at low loads.

## Capacities from 3000 lbs/hr to 60,000 lbs/hr

Riley Pulverizers are supplied in a range of capacity suitable for any size of modern boiler.

**RILEY**

STEAM GENERATING & FUEL BURNING EQUIPMENT

*For Complete Riley Pulverizer Details Contact a Riley Office in:*

Worcester, Atlanta, Charlotte, Chicago, Cincinnati, Cleveland, Detroit, Houston, Kansas City, Los Angeles, New York, Philadelphia, Pittsburgh, New Orleans, Portland, St. Louis, St. Paul, Salt Lake City, San Francisco, Seattle, Syracuse.

*Here's Why . . .*

# You Save With Silicone Insulated Outdoor Motors for Power Stations

Silicone insulation is establishing a trend toward less costly enclosures for auxiliary drive motors in power stations. By readily withstanding moisture and contaminants circulated in ambient air, Dow Corning silicone insulation makes possible more open enclosures and lower cost per horsepower.

Leading electrical equipment manufacturers already offer complete lines of silicone insulated "all-weather" motors in ratings from 100 to 5000 horsepower.

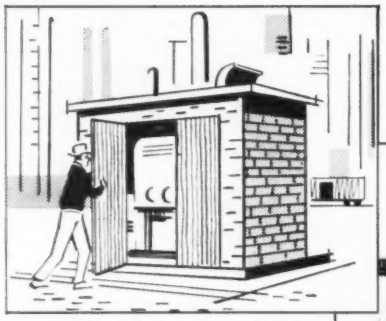
**Safe, reliable operation outdoors** the year 'round is assured by Dow Corning silicone insulation. Experience has shown silicone insulated motors readily withstand torrential rains, hurricane winds, corrosive fumes, fly ash, dust, salt air, snow, sleet, cold, heat — even flooding.

**Extra overload capacity** is provided by the silicone insulated windings. As a general rule, silicone insulation offers a 50% greater service factor and lasts at least 10 times longer than Class B insulation under similar operating conditions. That's why for the most dependable auxiliary drive motors, it's wise to

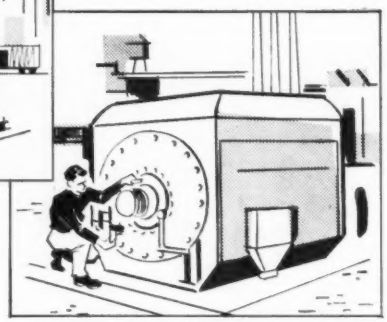
*Specify* DOW CORNING SILICONES and *Save*

JUST PUBLISHED!

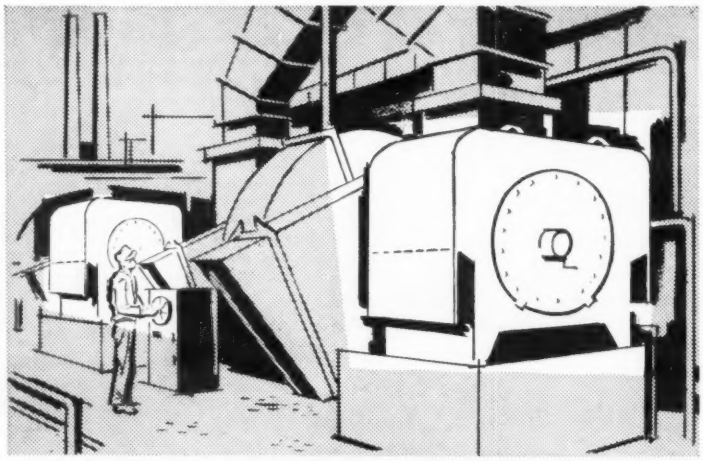
Send for your copy of new 8-page brochure detailing how silicone insulation cuts motor enclosure costs while adding to the reliability of electrical equipment.



Initially, motors were sheltered in buildings . . .



Later, motor enclosures themselves sealed out surrounding atmosphere



Now, silicones protect motor parts permitting the circulation of ambient air . . . lower-cost enclosures.

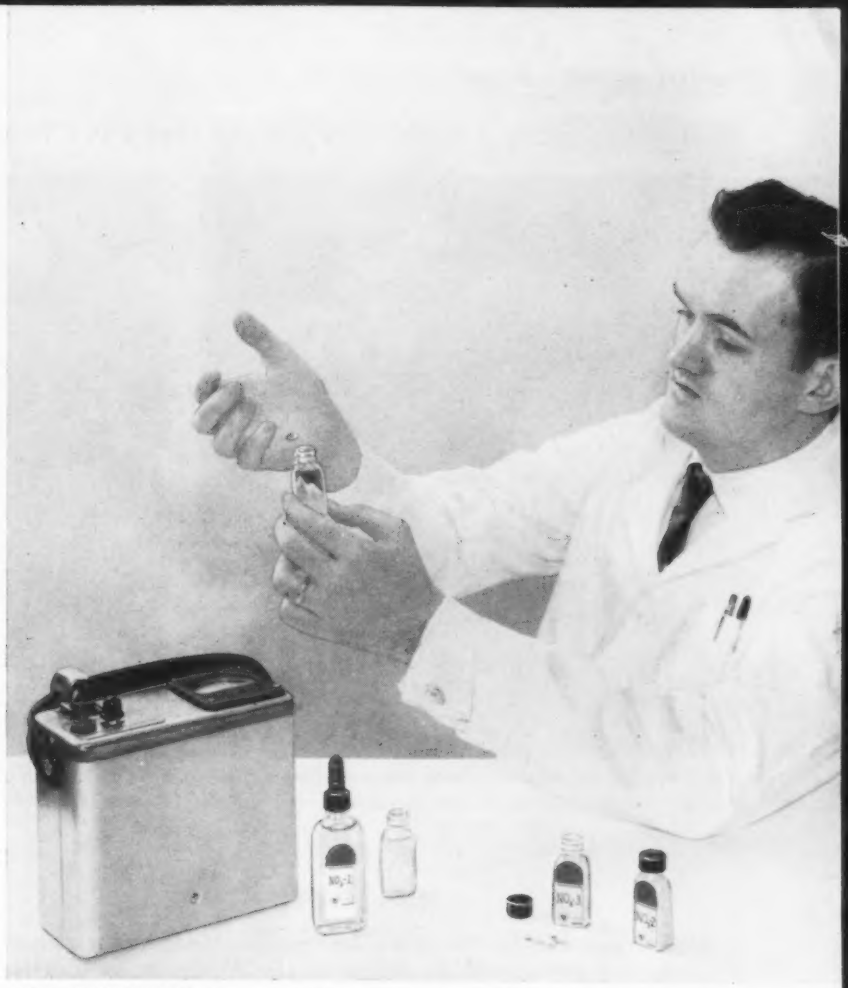
first in silicones

**Dow Corning CORPORATION**

MIDLAND, MICHIGAN

## Plant maintenance and management section

STEVE ELONKA
Associate Editor in Charge



**FIELD NITRATE TEST** has two of three reagents prepared in easy-to-use pellet form

Nitrate in boiler water helps prevent caustic cracking of boiler metal. And it can be a health hazard in potable water. In both cases nitrate testing is very important. Now, in less than ten minutes, you can make this...

# New, simple field test for nitrates

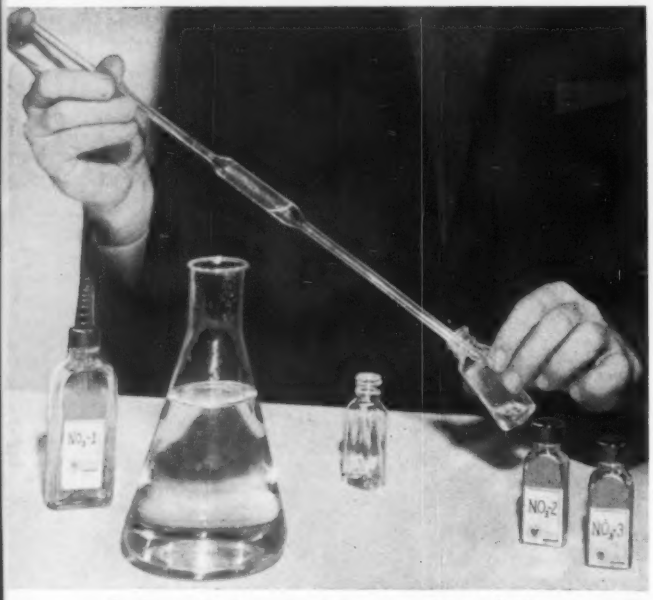
By R S ROBERTSON
and B J WACHTER
National Aluminate Corp

Nitrate in water can be either friend or foe. Fortunately, in boiler water, nitrate helps prevent caustic cracking of boiler metal. But, if enough is present in potable water, it can be a health hazard. It may even cause trouble in demineralizing plants. So in all cases it's important to know how much nitrate is in the water.

Most nitrate tests are essentially lab procedures that are difficult to run properly and often involve hazardous reagents. The RDC (reduction-diazotization-coupling) method that we've developed has been extensively field tested. It's simple to use and relatively free from common interferences. Accuracy is more than satisfactory. Two of the reagents are pelletized for convenience and reliability in the field. And the complete test can be run in less than 10 min.

Turn page ►

## Here are the five simple steps for field testing nitrate in water




1 Pipette 3-ml sample of clear water into each of two test cells. One is used as a blank to correct for any color and turbidity

2 Add 12 ml of distilled water to both original and blank samples. Put 1 ml of first reagent, $NO_3$-1, *above*, into each; mix

**RDC nitrate test** has the same sensitivity and overall accuracy as many laboratory methods. But procedure is much simpler and the usual interference from organic matter, found in water, has been eliminated. It involves reducing nitrate to nitrite, and diazotization followed by coupling to produce a reddish-colored solution. Color intensity is then compared visually with color standards or measured photometrically to determine nitrate content of the water sample.

**Innovations** include: (1) Provision for simultaneous reduction-diazotization-coupling to give better control of reactions, more accuracy, and fewer interferences. (2) Reagents that eliminate turbidity by producing completely soluble reaction products. (3) Use of pellets to insure properly measured and combined reagents, increase stability and to minimize possibility of reagent contamination.

**Field-test procedure** is outlined in the photographs above. A portable photoelectric colorimeter is used with test cells of 18-ml volume.

The three reagents needed are safe and will remain stable for at least four months. Here's how to prepare them: (1) $NO_3$-1—dissolve 42 grams of tartaric acid and 6.5 grams of manganous sulfate monohydrate in distilled water and dilute to 100 ml. (2) $NO_3$-2—mix by grinding in a dry mortar 97.5 grams NaCl and 2.5 grams N- (1-naphthylethylenediamine dihydrochloride). Make into pellets weighing about 135 mgs. (3) $NO_3$-3—mix by grinding in a dry mortar 74 grams NaCl, 10 grams urea, 3 grams zinc dust and 3 grams sulfanilamide. Special precautions are necessary for mixing this reagent. Then make into pellets weighing about 135 mgs. Don't attempt modifications without further study.

If you suspect that the nitrate content exceeds 75 ppm, use a fractional sample. In the range of 0 to 10 ppm nitrate use the 15-ml sample described above without dilution.

**Interference** from over 0.5 ppm $NO_2$ or over 15 ppm $SO_3$ can be controlled by proper use of hydrogen peroxide. In those rare cases where soluble copper exceeds 1 ppm, interference can be controlled with NaCN.

Test accuracy using the portable electric colorimeter without filter is:

| *Nitrate content (as $NO_3$)* | *Standard deviation* | *95% confidence limits* |
|---|---|---|
| 0 -25 ppm | 1 ppm | 1 ppm |
| 25-75 ppm | 4 ppm | 5 ppm |

This accuracy is completely adequate for a field test. Lower limit without concentration by evaporation or ion exchange is about 0.2 ppm $NO_3$ on a 15-ml sample.

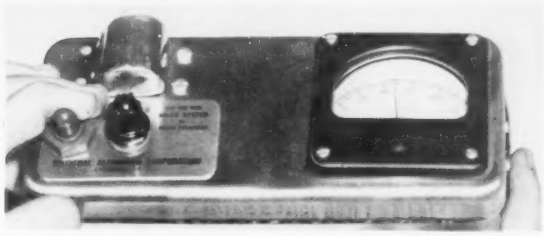
**Water conditioning** is one area where nitrate tests are important. Several years ago, there was the case of a new industrial demineralizer giving poor performance. Design figures and calculations were checked, but capacity continued to be about 20% lower than expected. Close inspection of the equipment and exchange resins didn't show anything wrong.

Finally, the water supply was retested showing an increase in nitrate of about 22 ppm since the original analysis. This amounted to 20% of the total anions present and accounted for all the lost capacity.

Radical changes in nitrate are quite common in areas where the water source is contaminated by industrial wastes, fertilizers or decaying vegetation. Possible contamination can be

4 Zero colorimeter with the blank. Then, five minutes after both pellets are dissolved in sample, insert in colorimeter, *above*

3 Next, add one $NO_3$-2 pellet and one $NO_3$-3 pellet, *above*, to first sample only. Mix slowly until completely dissolved



5 Read color intensity on colorimeter dial, *right*, and refer to calibration charts for results in ppm nitrate present in sample

checked by making regular nitrate tests over a long enough time.

Nitrate may also contribute to degradation of cation exchangers operating on the hydrogen cycle. In addition, nitrate exchanged by highly basic anion-exchange resins is difficult to remove by regeneration and may interfere with performance.

**Public health** is affected when the sodium-nitrate content of potable water is too high. Methemoglobenemia is the medical term describing a lack of oxygen in body tissues. It turns tissue blue, particularly in the lips and fingertips. Sudden occurrence of this disease in infants was finally traced to relatively high nitrate in drinking water or milk.

One study of 139 cases of methemoglobenemia in infants brought out that the water averaged 102 ppm nitrate at the time of sickness. When it was less than 10 to 20 ppm, the disease wasn't evident.

High nitrate, found in water from shallow wells, generally comes from fertilizer or plant-life contamination. But high nitrate is also found in deeper wells. And the amount of nitrate from any one well can vary widely from season to season. One well in Iowa, tested at four different times during the year, had a range of 20 to 70 ppm nitrate. With wide fluctuations like this it's important to make regular nitrate tests on all potable-water supplies.

There's an interesting correlation between nitrate and the amount of harmful bacteria in the water. One study of well-water samples showed that 81% of samples with nitrate contents of 10 ppm or more contained harmful levels of bacteria. Perhaps the nitrate test can be used to give an indirect indication of biological contamination.

**Caustic cracking** is a selective type of stress corrosion that attacks and weakens grain boundaries of steel. It's important to watch in older operating boilers with riveted drums. But it can also cause trouble in the stressed tube ends of welded boilers.

Many boiler-water treatments for caustic cracking have been evaluated. These tests and actual experience show that sodium nitrate is one of the best inhibitors. It's particularly good combined with organic treatments containing lignins or tannins.

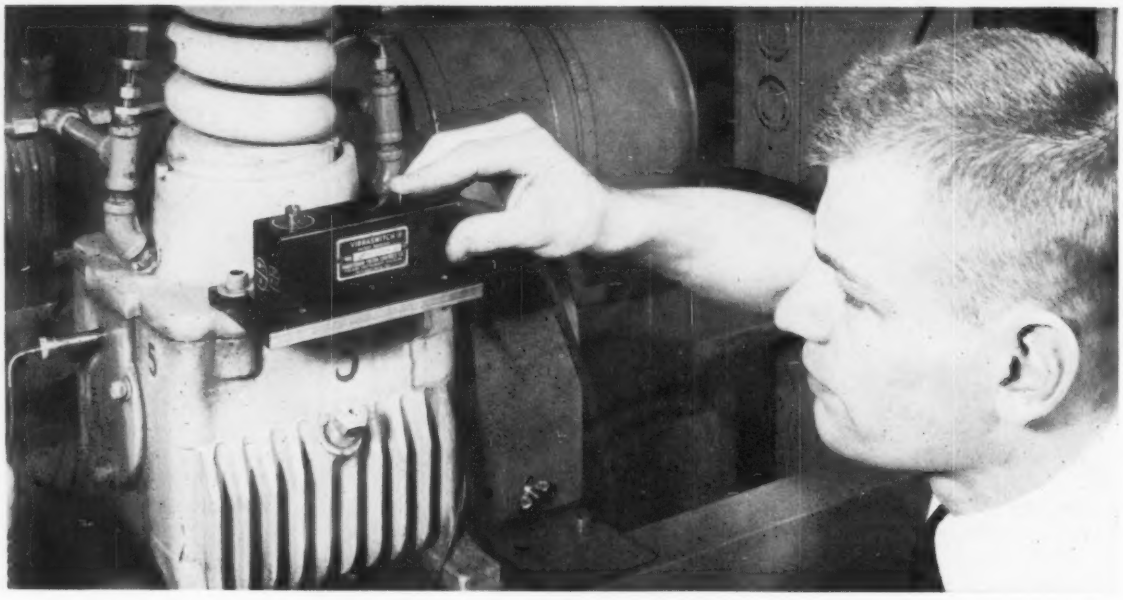
The ASME *Boiler Code* lists sodium nitrate as one method of preventing caustic cracking. A simple field test like the RDC method will be invaluable for controlling nitrate in boiler-water treatment—especially since it's free of interference from the various organics used with the nitrate.

**Water analyses** are generally checked by balancing the cations against the anions. The error in analysis is equal to the difference divided by their sum expressed as a percentage. Until recently, nitrate was not run routinely on water samples. So those waters containing nitrate would show some discrepancy between anions and cations. The use of a simple nitrate test will be very helpful in checking out these water analysis errors.

**Sodium nitrate,** commonly overlooked in water testing, is important in potable waters and in water undergoing ion-exchange treatment. It effectively prevents caustic cracking in steel and, as such, finds use as a chemical treatment for boiler water. Routine control of nitrate with the RDC test method fills a definite water analysis need in all these applications.

OPERATORS' NOTEBOOK **120**

# Now, you can protect



**VIBRATION DETECTOR** is adjusted to protect the bearing test stand; it shuts down stand if the bearings begin to operate faultily

## Here's how switch works, what it does

Vibration switch, photo above, anticipates trouble in rotating or reciprocating machines by continuously monitoring vibration or roughness of operation. They are used on both attended and unattended equipment. Reason: Many troubles progress too rapidly for operating personnel to take action in time to prevent complete failure.

When the vibration level exceeds normal by a preadjusted amount, the switch goes to work, shutting down the protected equipment. It will also sound an alarm or light a warning signal, depending on the job you want it to do.

Troubles such as failing bearings, bent shafts, broken blades or imbalance occur simultaneously with an increase in vibration. At times, vibration is a low-amplitude high-frequency "noise," clearly heard for several seconds or minutes before complete failure. Example: Vibration that's produced by a failing bearing that, at first, is at extremely small amplitude. A displacement type vibration meter can not measure it.

Since sensitivity of this switch increases with frequency, it senses either increases in amplitude at the operating speed or high-frequency chatter, noise or shock associated with many types of troubles.

Switch gives you protection not offered by devices that measure only shaft eccentricity. It's not like devices that respond only to substantial amplitude change, as shown by wavy lines in sketch. Here, the same condition of vibration in terms of displacement, velocity and acceleration are illustrated. Wavy line represents fundamental vibration at operating speed, corresponding to either a normal or accepted amount of vibration.

**Roughness** on the curve is caused by a failing bearing. In terms of velocity and acceleration, the change is pronounced, but the relative increase in displacement is negligible.

This model has an acceleration-sensitive switch element designed for smooth response to 200 cps (cycles per second), or 12,000 rpm. It has range up to 2 *G*'s to cover most types of rotating machines. It's also made for speeds to 18,000 rpm with range of 3 *G*'s. (*G* refers to acceleration equivalent of gravity, or 386 in. per sec squared. For a pure harmonic vibration, the acceleration in *G*'s is: $G = 0.05\,Af^2$. Here, $A$ is the double-amplitude or peak-to-peak displacement, in.; $f$ is the frequency, cps.)

**On most machines,** shocks and roughness are present, causing the *G* level to be much greater than would be expected from calculation. The vibration switch detects an increase in vibration above the normal level, which is determined while adjusting the switch. No prior information on either the normal vibration level or the correct shutdown lever is needed to install and adjust this instrument.

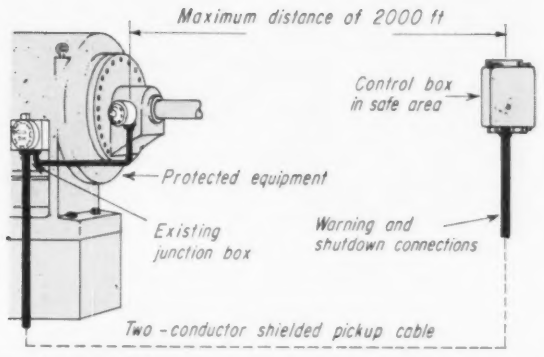
### Where to install

Vibration switches can be used to protect the following equipment:

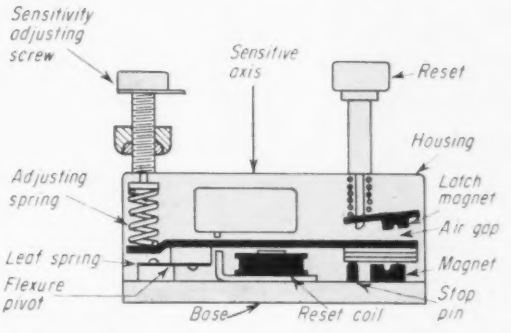
**Large fans, blowers,** having expensive rotors that can be damaged either by imbalance from accumulated

# machinery against vibration

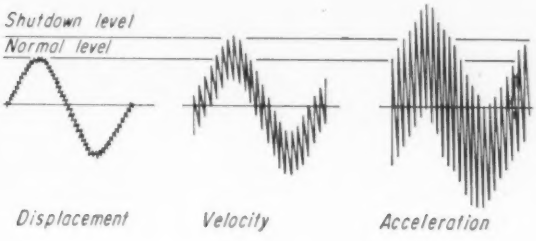
By STEVE ELONKA, Associate Editor




**TYPICAL INSTALLATION** is on bearing of equipment to be protected. Here are components that you need to wire the hookup




**GAP THICKNESS** of switch is controlled by relative height of the magnet, shims and the rounded stop-pin, as shown above




**WAVY LINE** represents fundamental vibration at operating speed, corresponding to a normal or acceptable amount of vibration

blade deposits or bearing failures.

**Air, gas compressors** that may have failing rod bearings and part breakage. If undetected, cylinder parts can be damaged severely. High-speed compressors in refineries accumulate tars when filters are bypassed, causing fires and major overhauls when failures occur.

**Pipelines.** Crude, product and natural-gas pipelines all have machinery that need protection.

**Centrifuges,** bearing test stands, gas turbines, large motors—in fact every type of rotating and reciprocating equipment that needs protection.

## How switch works

Armature, sketch, has only one type of movement: by a frictionless flexure pivot. Pivot is of two overlapping blocks and a leaf that's spring loaded in one direction to hold the blocks together. Any elastic freedom of movement at the pivot, other than rotation, will affect the flat frequency response.

The armature rocks on the pivot like a seesaw; it's forced in one direction by the adjusting spring, held in the other direction by a magnet acting through a small air gap. Gap thickness is controlled by the relative heights of the magnet and shims and the rounded stop pin.

When the assembly is subjected to vibration perpendicular to the base, the peak acceleration times the effective mass of the armature produces an inertial force. Force is aided by the spring that tends to pull the armature away from the stop pin and open the air gap.

When the peak acceleration exceeds the set level, the armature leaves the stop pin, increasing the gap. Then, the armature continues to move up until it strikes the latch magnet, actuating the switch on the way up. Normally, weights, spring and leverage ratio are selected to cause one revolution of the adjusting screw. This screw depresses the spring to give a one *G* change in the set level.

**Device may be reset** by depressing the reset button or by applying power to the electrical reset coil. An emf applied to the coil (even one well below that needed for resetting) will prevent the device from tripping.

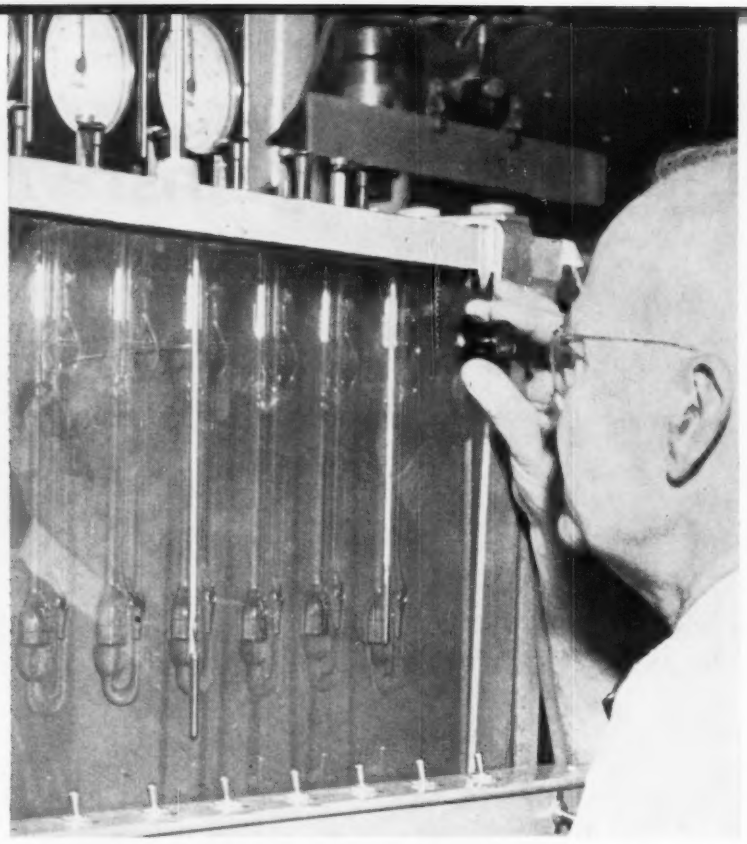
## How to install

In all housings, the switch is mounted so the sensitive axis is perpendicular to the base of the mounting surface. Normally, for machines with vertical or horizontal shafts, the switch is mounted on a near vertical surface so it's sensitive to the horizontal component of vibration. However, it may be mounted in any direction that you choose.

On machines with a low vibration level, it's mounted on the bearing pedestal or at a point where the normal vibration is heavy. On machines where the maximum normal vibration level is high and likely to be beyond the switch's range, mount the switch near the base or at a point where the normal vibration is within range.

*—Courtesy, Robertshaw-Fulton Controls Co, Fielden Instrument Division, 2920 N 4th St, Philadelphia, Pa.*

By W M KAUFFMANN, Chief Engineer
Engine Division, Worthington Corp



**KINEMATIC VISCOSIMETER** can be used in lab or field for determining viscosity. Periodic checks should catch changing viscosity values before bearing failure occurs

**Lube oil selection is based on many qualities, all affecting machine life. But, never forget that . . .**

# Viscosity is still the key to good

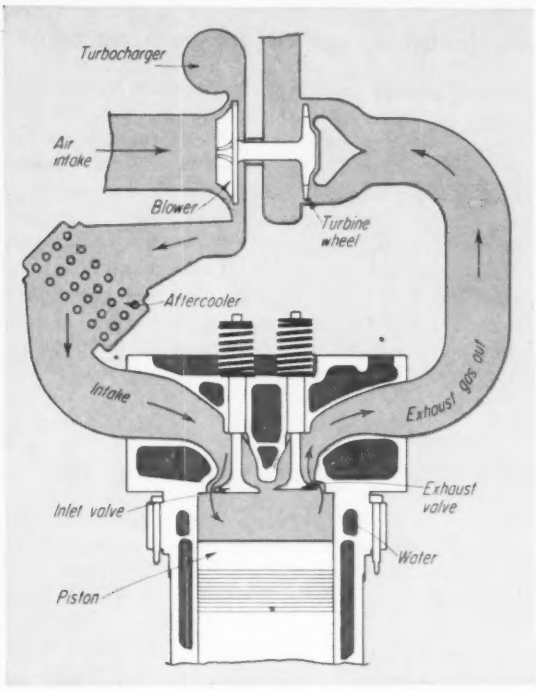
Designers recommend suitable lubricants before sending their machines out to the customer. To do this, they must juggle all the variables and come up with an oil that will fill the bill; one that fits all normal, plus a few uncommon, operating conditions.

Diesel engines and air and gas compressors demand well-defined lube limits. First, lube oils must maintain stability while performing the basic lubricating job. Second, you don't want to use an oil that tends to form sludges and deposits. Third, the oil must resist effect of a reasonable quantity of contaminants, such as carbon, water, fuel oil.

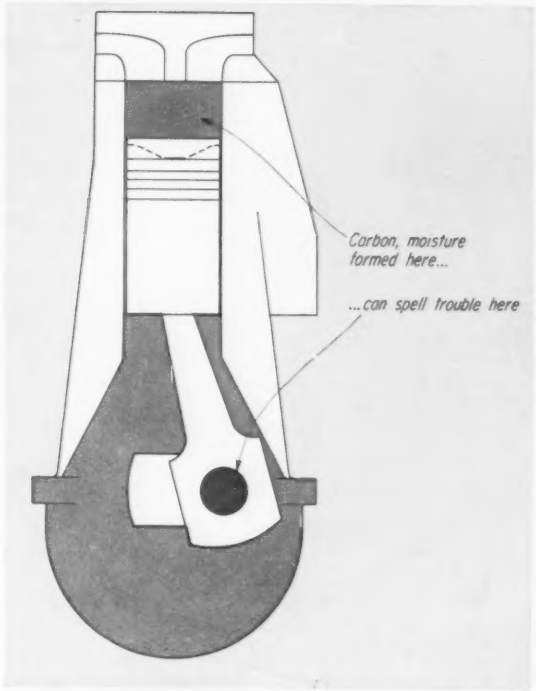
Meeting these limits isn't always easy. If the viscosity goes way out of line, wear skyrockets. Yet, there are many operating conditions that seem specially designed to affect viscosity the wrong way. If oil is diluted, oxidized, contaminated, improperly mixed as makeup is added, or if the wrong lubes are picked, you'll end up with increased wear. And there's only one solution to that problem—proper lubrication.

**Qualities needed** for good lubrication are many, but one is far over the others in importance: viscosity. Put simply, it's a measure of the oil's internal resistance to motion or flow. Viscosity is important since it governs load-carrying capacity, film thickness, ability to flow and often wear.

Any oil faces a series of operating hurdles in an i-c engine, generally in two main areas. First, in a diesel engine, it's the piston-cylinder area that's critical. Here, high flame temperatures, intermittent high firing loads, corrosion and a changing heat-transfer gradient to the cylinder-jacket cooling water can raise hob with some lube oils. One major troublemaker for the piston-cylinder setup is heat, and much is done to keep it under control. Cooling effect is increased by using light walls and a waffle-like underside to the top surface. Lube oil is often used as an internal coolant in conjunction with the heat dam effect (this restricts the heat flow to the piston-ring belt). Narrow power rings can be used because of the lowering of ring temperatures. These make good sealants since they transfer little heat to the lower portion of the piston. You can get good oil control by using conformable rings with flexible scraper edges, backed by helical or grid type springs. This produces lube consumption values of 15- to 20,000 bhp-hr per gal of oil. Detergent oils in the recommended viscosity ranges are satis-




**HOT AIR** at blower outlet is cooled by aftercooler. Lubes used for pistons and bearings should be OK for exhaust-valve stems




**CARBON AND WATER,** caused by poor combustion and jacket temperatures below dew points, hinder or destroy lube's efficiency

# lubrication of i-c engines

factory at these low lubrication rates.

A second critical area is the crankshaft connecting rod and main journal bearings. Rotating elements have to be hefty enough to maintain bearing loads. Designers must evaluate the polar diagram summation of inertia and power load forces at each bearing in order to establish mean bearing loads applied during the engine's combustion cycle. The relative $ZN/P$ value is one good basis for design acceptability.

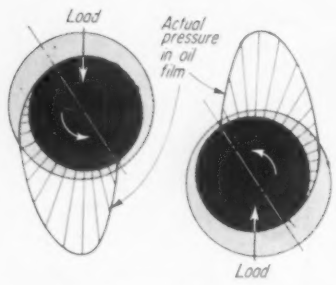
**Babbitt linings** as thin as .007 in. are used today. Thus, engine builders can still take advantage of the good features of babbitt as a bearing metal and limit effect of the alloy's low load capacity. Other alloys have been used successfully, but greater loading ability is offset by loss of embedding, conforming and antiseizure qualities. Full-flow filtration system is gaining acceptance as a standard for optimum elimination of abrasives and carbon.

**Outside interferences** have a telling effect on crankshaft bearings. A change in engine load increases wear rates; the bearing load position shifts and forces a break-in of new contact areas. Rpm, changing viscosity, loose dimensions, film thickness and rate of change in bearing load position all affect the lube oil load-carrying capacity. (Load capacity is defined as the load that produces minimum oil thickness and prevents contact between bearing and journal surfaces.)

In the crankcase, lots of things happen to the lubricating oil—most of them bad. Dilution weakens the oil, lowering viscosity rating and load-carrying capacity. This means increased wear, especially if abrasives are present. If more than 5% dilution occurs, the lube drops about one full SAE grade and is generally considered inadequate as a lubricant. Dilution comes from unburned oil, leaky fuel injectors and fuel-pump guides.

**Water** also finds its way into the crankcase. It aids any foaming tendencies the oil might have, as well as assisting in forming emulsifying sludge deposits. Condensation and leaks from wet sleeves let moisture get into the oil. You can stop the first by using higher water-jacket temperatures and keeping crankcase heats above the dew point of cooled exhaust and blowby gases—somewhere around 150 F should do the job. The second cause of water usually requires a maintenance job (replacement of sealing rings).

**Oxidation** affects lubes by in-

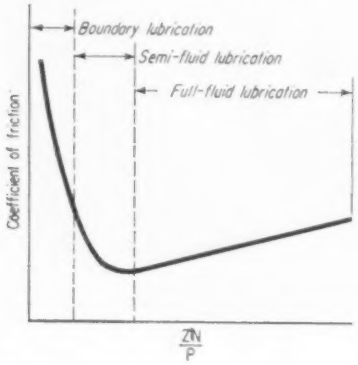



**DESIGN TOOLS** are important for accurate selection of lubricants. Polar summations come into play when preciseness is needed; $ZN/P$ can approximate working conditions

## Diagrams show location, size of pressure patterns

Oil film between shaft and bearing surfaces is not the same around bearing. Actually, a wedge of oil forms separating the two surfaces. Pressure exerted on film is greatest in wedge areas and drops off suddenly as film approaches point where journal and bearing surfaces converge. Pressure points move around bearing periphery as load direction changes. Polar summation diagrams are the picture statements of these effects.

Typical example of changing load is a diesel or compressor. Not only does the direction change, but also the amount. Increase in pressure, if within reason, isn't too much of a worry. As load on a lube goes up, so does the lube's viscosity and its load carrying capacity—that is, as long as shaft's radial motion continues. Thus, it is effective in accepting reciprocating loads such as met by piston pins.




## ZN/P provides handy, approximate design tool

Although unit combination is odd, $ZN/P$ yields a number that's both easy to handle and convenient to use. It's only an approximate approach to analysis, but it gives a rapid means of determining if film breakdown is about to occur. Symbol $Z$ is viscosity in centipoises, $N$ is shaft rpm, and $P$ is average pressure in psi.

Graph indicates three different types of lubrication. Full-fluid means complete surface separation by a film. Semi-fluid is a combination of full-fluid and "no-fluid" lube action. Some spots are separated, others touch. Overall wear is not serious. Boundary condition occurs when there is no film, such as shown by dry bearings or in starting.

creasing their viscosity. Rate of oxidation is affected by oil temperatures that are too high, and high sulfur and low cetane fuel oils. Correct use of additives controls this situation. Many actions produce insolubles: poor fuel quality, injection problems, incomplete combustion, overload, worn piston rings and low jacket-water temperatures. Good filtration practices keep these contaminants under control, but in each case corrective procedures in either design or plant operation must be employed.

A third area, perhaps not so critical as the piston and crankcase areas, is the exhaust valve and valve-gear assembly. Output increase in modern engines through turbocharging hasn't raised exhaust-valve temperatures too much. Cool air, obtained by aftercooling the turbocharger's blower discharge, thoroughly scrubs engine valves during some 120 to 140 degrees of the combustion cycle. Also, high velocity coolant flow through the cylinder head tends to reduce stem temperatures by improving valve-guide cooling. Lubricants with viscosities adequate both for journals and pistons will usually be OK for exhaust valve work.

**Designers** are taking a critical look at cold-service gas compressors. Today, many small skid-mounted units doing pipeline work by necessity get only passing attention. For these applications, effective lubrication is a must. Low-temperature resistance to cranking presents a real lubrication obstacle. Lubes must have low-temperature starting ability, keep a reasonable viscosity at high running temperatures and be economical.

One solution is the use of a polymer in the lube. Oils of this sort, called "multigrade" or "multiviscosity grade" oils, permit starting resistances that aren't out of line, also provide sufficiently high viscosities during operation.

Mechanism of viscosity index improvers is fairly complex, but indicates, in relation to temperature change, that oil behavior depends on the relative shear rates and stresses during cold starting. Large temporary viscosity losses during cold cranking are due mainly to reduced low-temperature shear stress brought on by the polymer.

**Viscosity's role** in lubrication also affects other compressor areas: piston-rod packing, cylinder walls, valve elements, unloaders, etc. Best lubrication is based on manufacturer's selection of an oil suitable for service involved. You can control both flow and viscosity here since force-feed lubricators are used. Oil feeds will vary from 2 to 4 drops per minute and never less than one per minute. In starting up a new compressor, feed lube liberally to the cylinders until a smooth glazed surface is obtained. Then you can reduce feed to the minimum specified by the manufacturer. (*Continued on p* 158)

Author Ken Roberts uses tubing sections to simulate expansion-joint action in discussing an engineering point with Yarway's Bill Miller

**You can't lose in the "give and take" of piping temperature changes if you make it a point to...**

# Know your expansion joints

By K S ROBERTS, Mechanical Engineer, Yarnall-Waring Company

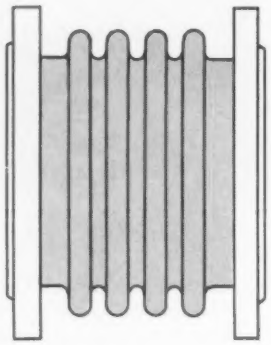
A steady advance in steam-generation practice is packing more heat energy into each pound of steam. And modern thermal-insulation materials and application methods are becoming more efficient in preventing heat-energy escape during transmission from boiler to point of use. So, with ever-higher initial temperatures and piping's lessening chances to relieve thermal expansion through radiation, today's expansion joints play an increasingly important part in preventing thrust loads on equipment and damage to piping system itself.

Our discussion is primarily concerned with slip type joints, but for perspective's sake let's look briefly at the other two basic joints used to absorb thermal expansion. Each definitely has a place, and choice for a particular installation is dictated by a number of factors, all of which must be reduced to dollars and cents.

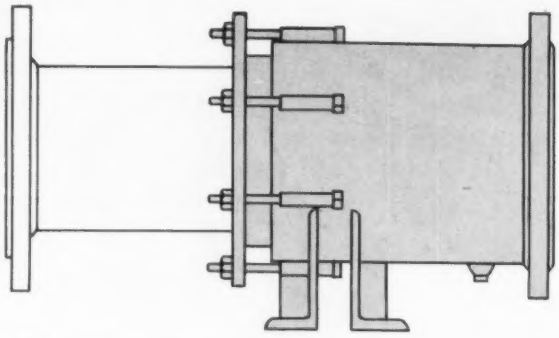
**Expansion bends** range from simple offsets or piping direction changes to loops or other configurations which take advantage of the pipe's inherent flexibility to absorb expansion. Major advantage of the loop or bend is that it doesn't require maintenance other than insulation care or, perhaps, servicing a trap on a condensate leg. Properly designed and installed, the loop is generally trouble-free and should last as long as the pipe itself.

Loops and other configurations require more space than expansion joints—a major consideration in many installations. Too, first cost of larger pipe sizes generally exceeds that of expansion joints, and pressure drop may be an important factor, especially with high flow velocity.

**Corrugated or bellows** joints are accordion-like sections which flex as the piping expands and contracts. Made of metal suitable for service conditions, they need no packing or lubrication. Stainless-steel corrugated joints can be used at tempera-



**BELLOWS JOINTS** can absorb axial, lateral and angular motion. They can be used at temperatures beyond the slip-joint range



**SLIP JOINTS** are rugged, dependable. Ring-gland type *above* makes piping-system shutdown mandatory to repack joint's stuffing box

tures far beyond the slip-joint range.

Flexing element is subject to metal fatigue and failure after a finite number of cycles. If you're replacing a corrugated joint or putting in a new steam line, give careful consideration to extent and frequency of operational cycles anticipated during the installation's life. Overstressing corrugations may cause premature failure.

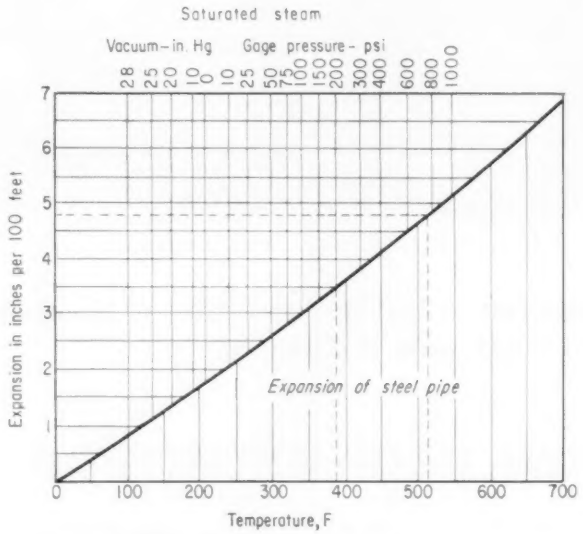
This joint will absorb lateral and angular motion as well as axial, but here again it's important to avoid chance of overstressing the flexing element. Specialized applications of the bellows principle—hinge, universal and gimbal joints—have found increasing use in recent years. Where used for axial motion only, it's essential to get accurate pipe alignment on either side of the corrugated joint. Built-in internal guides are available. Although they increase joint cost somewhat, they reduce number of pipe guides needed and considerably up chances of avoiding damage from misalignment.

Some corrugated joints are equipped with a sleeve-like cover over the working element. This protects element from dirt or contact with objects that might cause damage. Too, it reduces possibility of property damage or personnel injury in event of leakage.

**Slip joints.** A good slip joint is a rugged, dependable and economical means of absorbing expansion. It's particularly useful in steam and hot-water transmission lines where expansion cycles are frequent and large. While slip joints contain no highly stressed flexing element subject to fatigue failure, they do require periodic packing and lubrication maintenance. Amount depends largely on temperature, pressure, expansion absorbed (traverse) and frequency of operation.

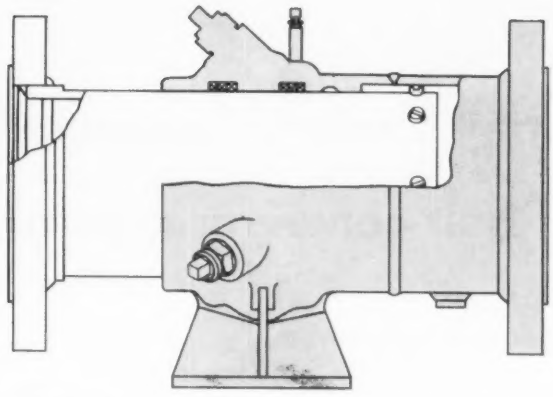
Probably the most objectionable feature of slip joints in the past was line shutdown required at periodic intervals to permit repacking the stuffing box. This was costly from both a time and labor angle. Effective solution is the gun-packed joint which allows packing to be inserted into the stuffing box at any time. Servicing the joint while it's under full temperature and pressure eliminates shutdowns and cuts maintenance time.

Proper installation is the key to

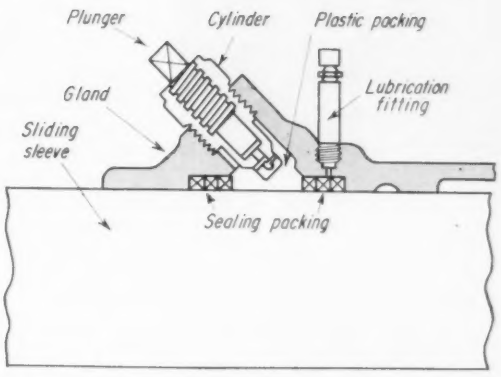



**JOINT TRAVERSE** depends on pipe length, temperature. Curve determines steel-pipe expansion for known temperatures, saturated steam pressures; adds 10% above actual expansion for safety

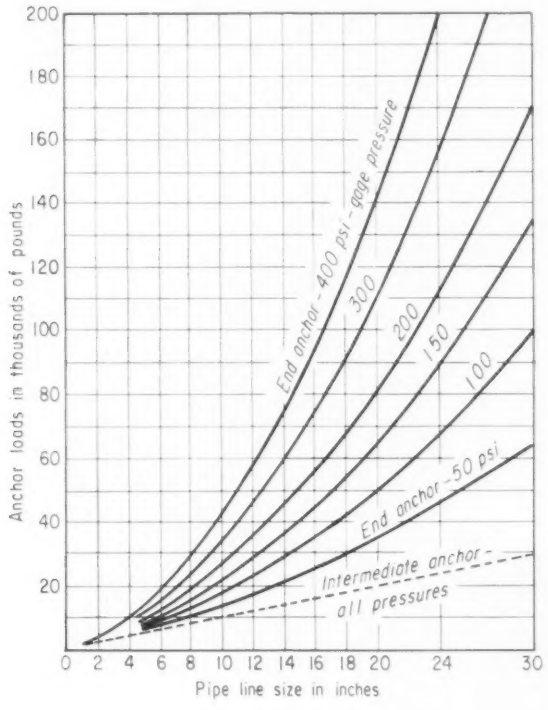
**ANCHOR LOADS** are sum of thrusts from internal pressure, packing friction, pipe-support friction. Chart determines loading, insures design compliance with ASA *Code for Pressure Piping*



**GUN-PACKED** slip joint removes expense of shutdown. Gun inserts plastic packing into stuffing box with joint under pressure




**LUBRICATION** injection fittings have check valves to prevent blowback. Normally, joints need oil only 2 or 3 times a year




long life and low maintenance expense. Joint should be carefully aligned with pipe, and guides should be located at correct distance so sleeve will move freely through stuffing box. Joint base should be secured with full complement of bolts. Joint body should have a valved drain to permit periodic blowoff of accumulated sediment. If condensate removal is desirable, connect trap to drain line. Another tip: Ample space around joint means easier, faster maintenance.

**Initial operation.** Joints should be checked for proper operation when the system goes into service. Normally, they won't need attention for the first few weeks. After a month or so, packing may need checking. If leaking, conventional gland-packed joints should have gland nuts tightened evenly until leakage disappears. In the gun-packed joint a few plugs of plastic packing (depending on joint size) should be inserted. After initial adjustment, a regular lubrication schedule (depending on joint type and service conditions) should be followed.

Good maintenance is primarily a matter of keeping packing tight and lubricated. Though most joints will operate without lubrication, piping stresses will be considerably reduced by a nominal amount of correct lubricant. This also helps retain the packing's sealing qualities. Good joints have alemite-type fittings for lever-operated gun injection of oil. Fittings are usually hydraulic or buttonhead and have built-in check valves to prevent blowback from stuffing box.

Gun-packed joints in continuous service usually need lubrication only two or three times a year. One shot in each fitting should be enough to maintain packing quality. Only in rare cases of relatively high temperature should it be necessary to increase this rate. Oil escaping between sleeve and gland indicates excessive lubrication. Always use lubricant recommended by joint manufacturer.

Traverse required in expansion joints depends on pipe length and temperature range. Curve, p 114, determines steel-pipe expansion in inches per 100 ft for known temperatures and for saturated steam pres-

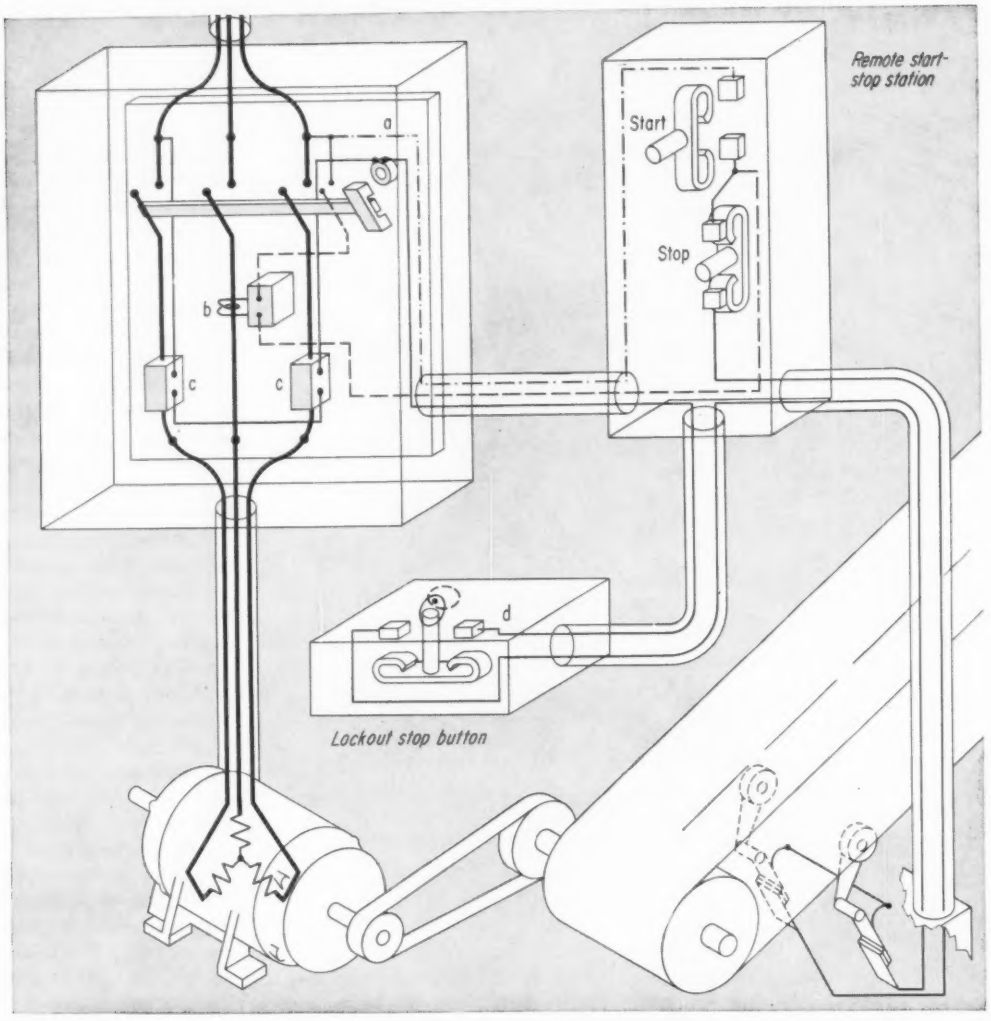
(*Continued on page* 160)

Plant
Electrical
Fact File

NO. 27: CONVEYOR CONTROLS

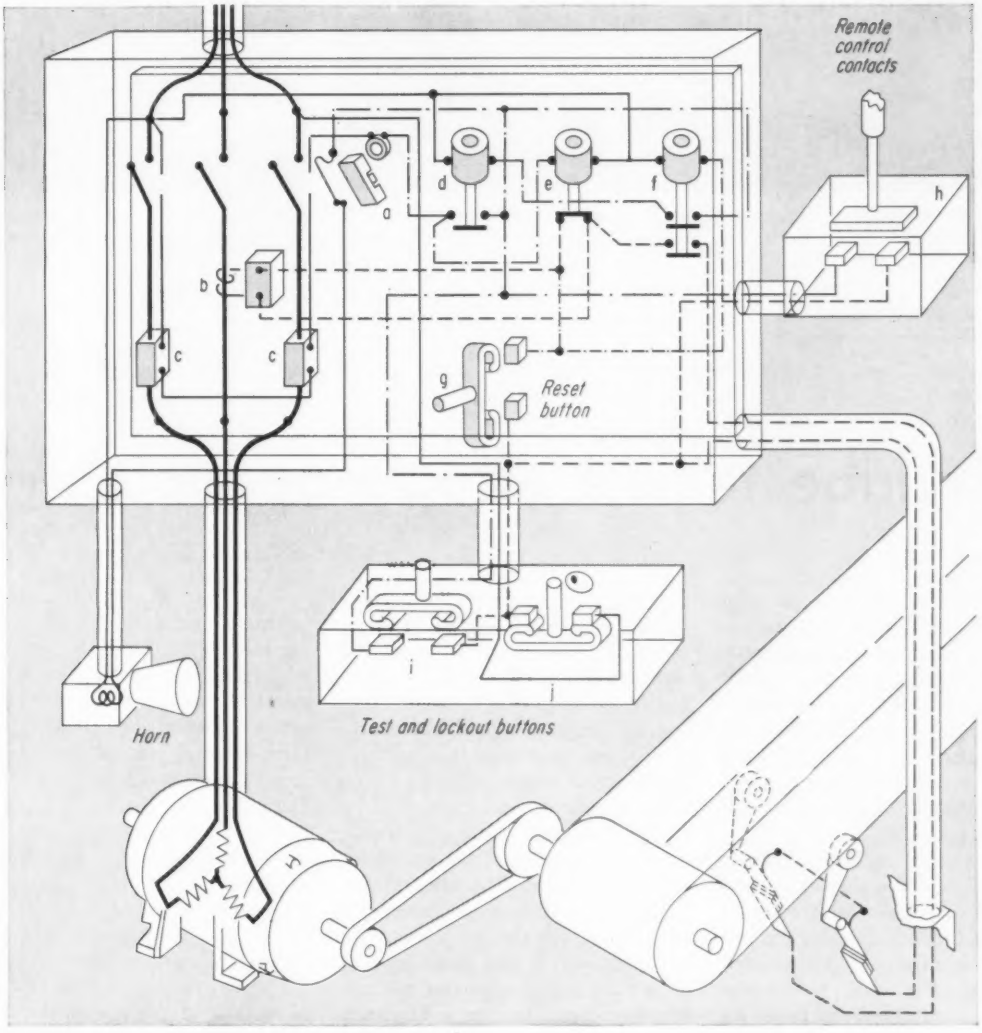
# Today's safety features for belt-conveyor control

By NORMAN PEACH, Assistant Editor

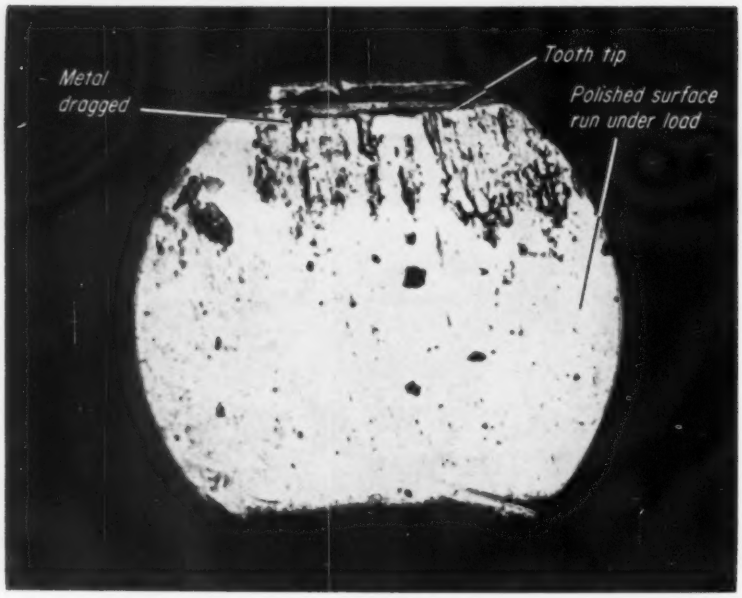



**MANUAL CONTROL** starts belt conveyor from remote pushbutton station. A lockout stop button *d* adjacent to the conveyor enables person near the belt to stop conveyor and prevent it from being started again. A lock on the button housing holds contacts open. The limit switches have rollers that ride on underside of belt near the edges. If the belt runs off either side, or belt breaks, the switches open and shut down the drive. A self-resetting overload relay *b* is in series with auxiliary contacts of holding coil *a*. Relay *b* is not in circuit while starting button is depressed, but if the belt jams it goes into operation to shut down conveyor. It's set above motor surges. Thermal relays *c* handle overloads.

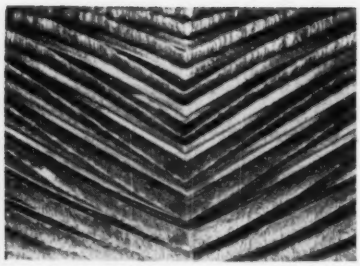
Belt conveyors, because of their length, can't always be kept completely under the surveillance of the operator. In other cases, it's desirable to have belt conveyors operate automatically from remote controls. Such conveyors can, in certain circumstances, be dangerous to personnel and equipment. To protect against accidents caused by a broken belt or a belt that runs off its pulleys, protective features can be built into controls. Here are schemes for manual and automatic remote operation.



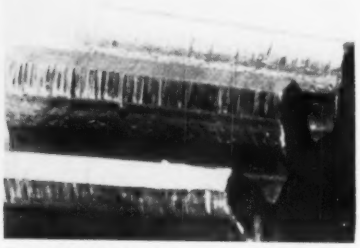

**AUTOMATIC CONTROL** starts and stops conveyor by opening and closing remote contacts *h*. Lockout contacts *j* must be closed; if all power has been off, reset button *g* must be pressed to close relay *f*. Closing remote control contacts *h* or test button *i* energizes horn and time-delay relay *d*. When relay *d* closes its contacts: (1) magnetic coil *a* closes contactor (2) auxiliary contacts open horn circuit (3) relay *e* opens, introducing self-resetting overload relay *b* into the circuit. Operation of relay *b*, stop lockout button *j*, or limit switches de-energizes relay *f*, cutting off control power until reset button *g* is manually depressed. The horn blows a warning just before the belt-conveyor starts up.




**SCUFFING OR GALLING** is usually noticed first at tips of the driven teeth. Metal may be dragged past the tips, as above. Bases of the driving teeth are also scuffed



**SEVERE SCORING** may result from using wrong lubricant; crude oil was used here



**COMBINATION** failure of driving gear. Note scoring above pitch line, pitting below

LAST OF A 4-PART SERIES

By E S REYNOLDS and J R HICKS, Socony Mobil Oil Co, Inc

# How lube failure affects gears

When gears fail, many people think first of lubrication failure, and of solving the problem by changing to another oil. This often causes delay in solving the problem, and further gear damage. Collectively, the other causes of gear-tooth failure (discussed in previous articles in this series), are more often involved than lubrication failure.

When enough oil is present, the sliding and rolling action of meshing spur or helical gear teeth tends to form a fluid film thick enough to prevent metal-to-metal contact. But speed, load and oil viscosity determine whether or not tooth surfaces are completely separated.

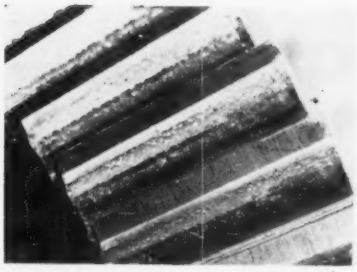
The relationships are complex, but can be stated partially as follows: (1) With normal tooth loading and oil viscosity for a given gear set, a fluid film can be maintained over a range of speeds. But if speed is too low, the fluid film does not form, and if speed is too high, it cannot be maintained. In the latter case, the oil film shears so rapidly that it heats excessively and viscosity is reduced below an effective value. (2) With normal speed and oil viscosity, a fluid film can be maintained up to but not above a certain tooth loading.

When a fluid film cannot exist between gear teeth, there is some degree of metal-to-metal contact. Boundary rather than fluid-film lubrication prevails. Minute roughnesses on one surface plow through those on the other surface. Where opposing high areas rub together, removing any protective coating, minute welds form. They break immediately, but not necessarily at the point where they formed. This welding and plowing results in metal transfer from one surface to the other and in metal particles breaking or pulling off. Tooth surfaces become rough and worn, and the profiles of the teeth are altered.

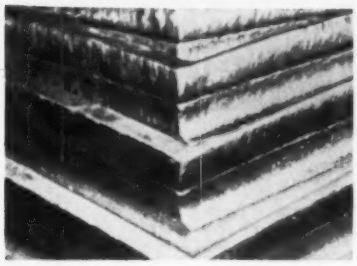
When you anticipate boundary lubrication conditions, use oils containing suitable film strength (anti-wear) additives. They form strong films on metal surfaces, usually by chemical action. These films reduce actual metal-to-metal contact and welding, and thus control wear and surface damage.

A well-lubricated steel gear tooth has a dull gray look. Less effectively lubricated teeth are brighter, sometimes even burnished to a mirror-like finish. Still less effective lubrication causes scuffing or galling.

Usually, you can see the first signs of scuffing at the tips of the driven teeth. These tips contact the bases of the driving teeth where both unit surface loading and sliding velocity are high, photo above, left. Note that pitting or spalling does not occur until after a long period of operation. But scuffing can show up as soon as your new gears are operated.



**LUBE FAILURE** and metal fatigue killed this driven gear. Note the pitch line ridge



**GROOVE** along the pitch line and the scored tooth surfaces indicates a lube failure

## Scuffing and pitting develop independently

The initial incidence of scuffing and of pitting on gear teeth is unrelated, according to T F Davidson and P M Ku, speaking at an ASLE meeting in October 1957. They were commenting on an investigation of lubricant effect on gear-tooth surface fatigue, conducted at Southwest Research Institute.

The tests showed that as pitting became advanced, severe scuffing of the pitted teeth almost invariably resulted. But there was no evidence that severe scuffing led to pitting.

Pitting or scuffing could initiate on any tooth, independent of the scuffing or pitting patterns existing at the time. Pitting, whether light or advanced, was almost always confined to the pitch-line region. The root and tip regions, where sliding velocity was high, were always more prone to scuffing.

Lube viscosity, at least as measured by conventional viscometric methods, did not have as predominant an effect on gear-tooth surface fatigue as other undetermined lube characteristics.

**Scuffing** often appears in other areas where both surface loading and sliding velocity are high. This happens, for example, at the tips of long-addendum pinion teeth and at the bases of the meshing short-addendum driven gear teeth. In spur gears, there is a period during mesh when one pair of teeth carries the whole load. Scuffing may occur at the points on the tooth profiles where full load is picked up and just before it is dropped (that is, shared with other teeth).

If the lubricant is incorrect for the job, or if the load is too heavy for any lubricant to withstand, scuffing may extend over the entire tooth surface, top photo, facing page. This is often called galling or scoring.

Bottom photo, facing page, shows a combination failure: scoring (lubrication failure) above the pitch line and pitting (metal-fatigue failure) below it. Tooth loading was heavier than either the oil or the metal could withstand.

Depression along the pitch line indicates that this is a driving gear (pinion). Sliding is away from the pitch line on the driver, and scoring usually develops a groove in this area.

Top photo, above, is another example of both lubrication and metal fatigue failure. As in the previous picture, this failure was the result of overload. But here there is a *ridge* along the pitch line, indicating that this is a driven gear. Under extreme boundary-lubrication conditions, metal is dragged in the direction of sliding—toward the pitch line on a driven tooth.

Note that a ridge or a groove along the pitch line is one indication of lubrication failure.

When areas below the pitch line become badly roughened by pitting (caused by metal fatigue), lubrication becomes difficult, and mating tooth tips start to scuff unless lubrication happens to be more effective than is usually the case.

**Lube failure** causes we have discussed include: (1) wrong oil—high or low viscosity, or lacking in film strength (2) load too heavy (3) speed too high or too low. The combination of high tooth loading and sliding speed that makes lubrication so difficult may result from improper tooth design. Also, if gears are not cut carefully, inaccurate tooth profiles and spacing can cause vibration and momentary overloads greater than any oil can withstand.

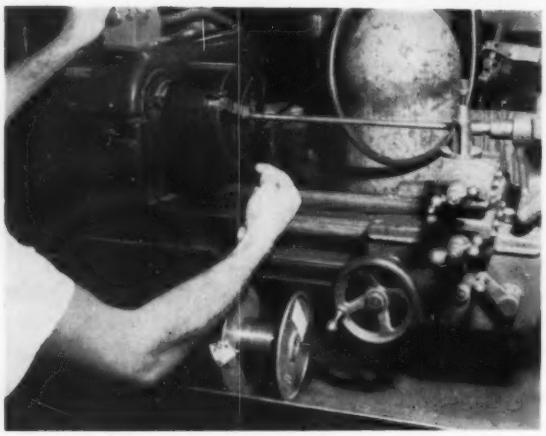
Excessive tooth loading can also be caused by misalignment, usually resulting from poor installation, a settled foundation, a "flexible" coupling that has lost its flexibility, or bearing wear.

Another cause of lubrication failure is wrong application. For example, if the oil level in a splash-lubricated gear set falls too low, not enough lubricant reaches the teeth. If the oil level is too high, extra agitation causes overheating and excessive thinning.

Also, in a pressure circulation system, too little oil will reach tooth surfaces if there are not enough nozzles to distribute it across the full tooth width, or if nozzles are not aimed correctly. Even in a good set-up, using poor-quality oil with poor oxidation stability eventually causes deposits that clog nozzles and restrict oil flow.

**Conclusion.** When gears fail, more than one kind of failure may be involved. One failure may lead to another, and evidence of the original trouble may be covered up. Thus, you must be familiar with all basic causes of gear failure, and make a careful diagnosis. This is neither easy nor always certain. In complex cases, the lubrication engineer, gear expert and metallurgist must cooperate to come up with the right answer.

# Timely **practical ideas** to help solve



## Shop lathe makes handy coiler for silver brazing rings

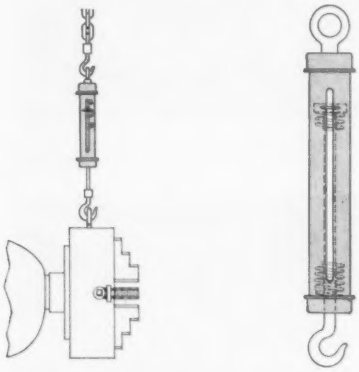
Photo shows a quick, easy way to make a large number of brazing rings from a spool of silver-alloy wire. Coil the alloy wire onto a mandrel revolved in a shop lathe. Then cut the coil into individual rings. These alloys are used for the production brazing of high-strength joints in a wide variety of ferrous and nonferrous metals.

To start the coil, insert the end of the brazing wire through a hole in the mandrel. Then secure by bending it around the circumference of the mandrel. With a little practice you can quickly establish the needed balance between wire feed and lathe speed to build up a compact coil of proper tightness on the mandrel. Wind the coil loose enough so it can be slipped off the mandrel. When coiling to a specified outside diameter, the mandrel diameter must be two wire-widths smaller than the desired OD of the ring.

When removing from the mandrel, cut the coil into individual rings by clipping it up the side with a pair of wire cutters. In this way several hundred perfect brazing rings can be made in less than 10 minutes. To prevent contaminating the brazing wire, your hands should be free of dirt and grease. While making the coil, it's best to pay out the wire between the folds of a clean cloth. Also, the mandrels should be stored in a clean place.

Lathe coiling these rings will save money where many rings are used.

—*Courtesy, Handy & Harman, New York, N. Y.*



## Spring stops guesswork

A king-sized fish scale solved one of our long standing headaches. We use several large chucks with our lathe and change them with a chain hoist. But changing process presented a problem since operators often got the hoist's chain too tight or too slack.

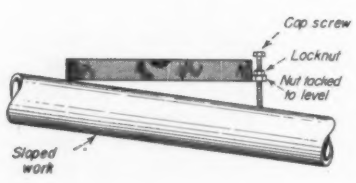
Sometimes they started lifting lathe and all before unscrewing the chuck. Or, by allowing chuck to drop off the end, they'd round off a spindle thread or two. We solved the problem with a homemade tensioning device, sketch, above.

Using a short pipe, spring and an indicator, we made a heavyweight spring scale. Scale was inserted between hoist and hook. As each chuck was test lifted, we made a mark on the pipe where the indicator stopped. Both the mark and chuck were stamped with the same number.

Now, to change chucks, operator simply tightens hoist until indicator is opposite the right number. When chuck is loosened it swings free with no thread burring or other trouble.

C MOLLY, *Bronx, N. Y.*

## Put a carpenter's level to work when installing pipe




When installing sloped piping, sewers or concrete slabs, we have found a carpenter's level, equipped as in sketch, very helpful. Attachment consists of a nut tacked to one end of the level, a cap screw and a locknut.

Assuming level is 2-ft long, project cap screw and lock below the bottom of level to a distance equal to twice the pitch per foot of work. Then use as shown. When used on level work, the cap screw is retracted and locked above the bottom of the level.

T R HARE, *Berkeley, Calif.*

# your tricky design and maintenance problems

STEVE ELONKA, Associate Editor

## Using limit switches for timing?

Here's an idea that can pay off in any area where limit switches are used. Our original setup had five manual operations per minute. We remodeled for machine operation at 15 per minute, with three limit switches to do the timing. Two additional limit switches provided electric braking and clutching operations. With this 300% potential increase in speed, defective products could be increased at the same percentage—whenever a limit switch failed.

Here's how we solved problem: (1) For the quickest replacement of a faulty 4-wire switch, a 4-wire receptacle was mounted adjacent to the switch. Then a switch was wired to provide plugging into the proper circuit. Also, an identically wired spare was made up and tagged for its proper location. (2) Later we learned that switch failure occurred when springs broke and provided an internal short. At times this blew more fuses in other circuits. In automated production, looking for such a defect and the consequent downtime was very costly. (3) Next, a lucite cover of approved type was placed on the limit switch for easy internal inspection without downtime. (This method located the defect but *did not* correct a short). (4) Now being used with success, are two limit switches mounted on top of each other. Both are parallel wired, plugged into parallel-wired receptacles and provided with lucite covers.

If a single switch fails, the windows provide easy visual inspection. By unplugging that switch, it and its theoretical short are eliminated.

I believe there are many variations of our solution that can be used in almost any industry having high-speed operations.

With automation making a strong bid, the plant manager can make good use of these limit switches. In our case they are extremely useful.

E T STEVENSON, *Takoma Park, Md.*

## What would you have done?

While in Venezuela as an electrical engineer I was sent to Maracaibo where my firm had completed a new hospital. They were having boiler trouble. Two 150-hp scotch-marine boilers had rotary cup mechanical atomizing burners. Fuel was bunker C.

Troubles were (1) excessive smoking (2) rotary cups kept burning away (3) refractory burner rings kept cracking and spalling.

Boiler plant was at foot of hill, with division manager's home at top. Wind direction was such that manager almost had to evacuate because of smoke when boilers were operating.

I learned that the operator had replaced the spinning cups and refractory rings several times but had been unable to get the burner to stop smoking. He had no instruction book for the burners, so I started checking the boilers.

First I noted that the only air entering the furnace was that supplied by the burner blower that helped atomize the oil. From size of boiler and burner I knew more air was needed for combustion. But I could find no way for more air to be fed into the combustion space.

I figured that secondary air was needed to prevent the rotary cup from burning. My reasoning was that cup burned because it was not cooled by air. Then it threw oil out on the refractory ring because it couldn't atomize the oil properly. And because the oil cooked and burned on the refractory, spalling and cracking resulted.

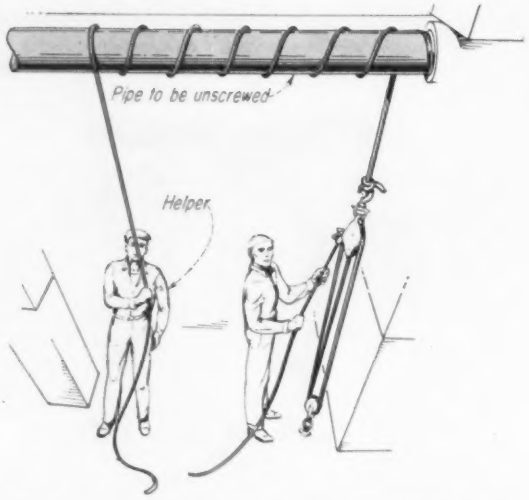
Looking closer, I found a metal door on the bottom of the burner mounting that was bolted closed. I had a mechanic unbolt it. That door turned out to be the secondary combustion-air register. After adjusting the supply door for secondary air, I made a few other adjustments on the burner. Soon the boiler was steaming better than ever—and it didn't smoke. What would *you* have done?

L J CORMACK, *Matairie, La.*

## Do you know...

how to run down air-conditioning troubles? Suppose you don't have enough cooling, or humidity is low, or you have mechanical noises. Or, perhaps there isn't enough heat, floors around your equipment are always wet, or odors are present in the conditioned spaces. If so, do you know what to do? *Plant Operators' Manual* shows you with over 1500 illustrations. McGraw-Hill Book Co.

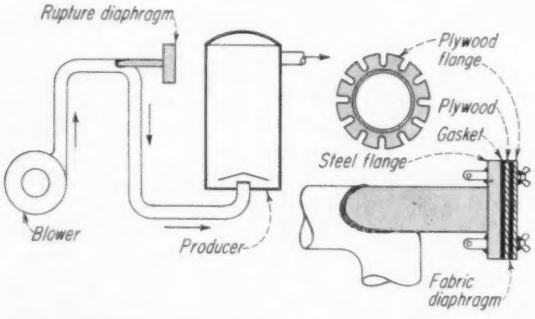
*Turn page for more Practical Ideas* ►




## Here's a rope trick you should know

At times we have to remove a heavy pipe or a valve that's in an awkward position where it's difficult or impossible to use a pipe wrench. We wrap a rope around the pipe and either clamp the end to the pipe or have a helper apply a tension, as in sketch. The other end is pulled with a block and tackle or a small chain block. This method removes the most stubborn pipe. The rope won't slip if the pipe is clean. We got this idea from watching a hoisting engine which used a small drum. The operator just kept a few turns on the drum and a light tension on the end of the rope while lifting heavy loads.

E JONES, *Bronx, N. Y.*

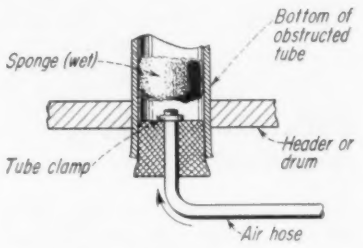



## Rupture diaphragm saves gas plant machinery

An explosion had badly damaged the impeller blades of an air blower in our producer gas plant. So we installed a simple rupture diaphragm on the air main leading from the blower to the producer, sketch. First a flanged branch pipe was welded to an elbow on the air main to form a tee. Diameter of the branch pipe is two-thirds that of the air main.

Rupture diaphragm is fitted to this flange and consists of a varnished fabric disk sandwiched and glued between two plywood flanges. Slots cut in the plywood flanges of the rupture diaphragm correspond to the bolt holes on the tee flange. Diaphragm is assembled with swing bolts and wing nuts. In case of an explosion, the diaphragm bursts, gives relief, prevents damage to the air blower.

A RANGANATHAN, *Jabalpur, India*




## Removing objects from boiler tubes?

POWER, Feb 1958, page 129 had a method for removing an object from a boiler tube. Another simple way is to use a synthetic sponge, available in any grocery or drug store. Cut a piece of sponge about equal to the tube ID, soak it in water until it swells. Insert sponge in the *bottom* of the tube.

Use an air hose, clamped to a plug, which closes off the tube end, sketch. Now, blow the sponge through the tube. Sponge acts as the wadding in a shotgun shell, pushing the object back up the tube. If the object is jammed so it must be cut out, the sponge can still be blown back down the tube since it shrinks as it dries.

I suggest that reader Barnes refrains from pushing fallen objects *down* a tube since they are likely to jam in bends where they'll be almost impossible to remove.

In recovering objects dropped in boiler tubes, reverse the definition of gravity and always use the rule: *What goes down must come up.* If not, be prepared to get a torch to cut out the plugged section of tube.

When installing new tubes, it's best to "ball and sponge" the tubes. The ball, pushed by the sponge, can be heard hitting the tube bends. By counting the "hits" you can follow the ball's progress. A small steel-bearing ball is the easiest to use.

J B OLMSTEAD, *Lynchburg, Va.*

**My biggest boner**

*Please turn to page 156*

# WELBOND®
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Welbond Valves are winning acceptance among modern steam plants for all high pressure, high temperature valve service.

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# These **plant problems** could well be yours...

## The problem

## Should we switch from jam type packing to mechanical seals?

We have three barrel type high-pressure boiler-feed pumps. Suction pressure is 35 psi, discharge 1400 psi. Suction temperature is 250 F and shaft speed is 3600 rpm.

We're thinking about replacing the jam type packing in these pumps with the newer mechanical seals. However, I'm worried about shutdown if the mechanical seals fail. With our present setup, we can always add another ring of jam type packing. But, shaft-sleeve wear is already excessive, giving us maintenance problems.

Before making any change, I'd like to know what experience POWER readers have had with similar jobs. —*MJD, April* POWER

## The solutions

### *MJD's* real problem is poor maintenance

*MJD* gives a definite clue to the cause of his difficulties when he says "We can always add another ring of jam type packing." Apparently this is his normal practice and undoubtedly the only ring of packing doing any good is the last ring installed. He'll probably find the other rings compressed to a fraction of their original size, burned hard and utterly useless. And the inboard end of his shaft sleeves will be deeply grooved by accumulated charred packing. In short, *MJD's* stuffing-box maintenance needs to be greatly improved.

My advice is to consult a packing manufacturer who specializes in high-temperature, high-pressure boiler-feed-pump packing. Follow his recommendations on installation and adjustment to the letter and then start off with new shaft sleeves.

The relatively mild suction conditions outlined by *MJD* should give good packing life. Of course, shaft rigidity and trueness, packing, bearing condition and coupling alignment must all be satisfactory. Under these operating conditions the packing should last from 12 to 18 months. I know of several barrel-pump installations with packed stuffing boxes operating at 400 psig and 400-F suction where packing life is consistently better than one year.

Mechanical seals on the other hand are not the panacea they are sometimes thought to be. This is particularly true on boiler-feed service where rapid failure cannot be tolerated. *MJD's* fears about this should not be taken lightly. How many mechanical-seal manufacturers are willing to state an expected life that's satisfactory? This is very important because of the major dismantling job needed and the high cost involved in replacing mechanical seals in barrel feed pumps. By comparison, packing replacement once every 12 or 18 months is a relatively simple job and bearings don't have to be dismantled with subsequent internal realignment. In my opinion *MJD* should stick to jam type packing.

T W EDWARDS, *Harrison, N. J.*

### Jam type packing gives top service

Shaft-sleeve wear indicates *MJD* is not handling the jam type packing properly. Are the packing-seal rings in the right position and are they working? Jam type packing is widely used and gives excellent service when correctly installed and maintained. So, before making any change, *MJD* should check his existing setup carefully. It may be that improved packing maintenance will eliminate the need for an expensive conversion to mechanical seals.

C G HOWARTER, *Canton, Ill.*

# ...Here's how *Power* readers would tackle them

ROBERT MARKS, Assistant Editor

## Here's a vote for mechanical seals

Many items must be considered before answering *MJD's* question. Instead of worrying about seal failure, he should consider cost of new seals and compare it with the amount of money now going down the drain for pump maintenance. One consideration, often overlooked, is the loss of heat and condensate with jam type packing. The packing is lubricated with the leakoff condensate, and this condensate combines with the gland quench water. So quite a bit of money goes to waste over a period of time in the form of condensate and Btu's. Add to this the cost of packing, mechanic's wages, and excessive sleeve-wear mentioned. Shaft sleeves on these high-speed pumps are usually made of stainless steel with a stellite inlay. So the cost of one sleeve isn't a minor item. *MJD* will find his tabulation of costs mounting rapidly.

We have a number of mechanical seals in service in our plants. All have been in operation two years or more and haven't given any trouble. One is on a constant-differential fuel oil pump in boiler service. Another is on a feed pump of the type *MJD* mentions. Still another is on a feed pump operating at 250-psi, 350-F suction and 2400-psi discharge. We installed all these.

In addition, our secondary fuel oil pumps are equipped with factory-installed seals. These pumps handle what amounts to still sludge and discharge at about 1400 psi. Our newest station, now under construction, will use boiler-feed pumps factory equipped with seals.

Have the manufacturer's engineer present to supervise the installation. Install exactly as directed since this has a major bearing on how long they'll last. My advice to *MJD* is "try 'em man, and I'll bet you won't be sorry."

H C Bosley, *Long Beach, Calif.*

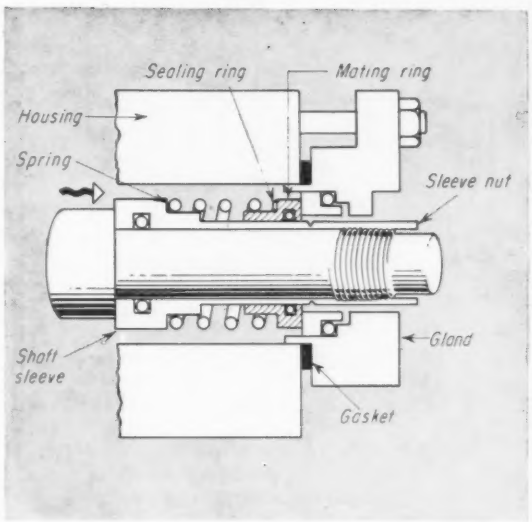
## Don't give up on the jam type packing

I would stay with jam type packing instead of changing to mechanical seals. With a temperature as high as 250 F, there should be a slight amount of lubricant going into the stuffing box at all times. *MJD* should also consider piping up his packing glands to a source of cooling water to help reduce operating temperature.

Since he is having trouble with shaft-sleeve wear, why not investigate the merits of a metal-spray job by a competent outside job shop?

Another important precaution is to make sure the pumps aren't subjected to severe temperature changes. Have the operators bring temperature up slowly before starting. Then, bring it down slowly before taking a pump off the line. Make one man responsible for the pumps to help reduce the excessive maintenance reported.

B A Crosson, *Cranston, R. I.*




## Mechanical seals have many advantages

Mechanical seals eliminate need for sealing condensate, cooling water, packing, pressure breakdown bushings and bleed-in and leakoff piping. Other advantages include limited downtime for replacing parts, minimum feedwater leakage and elimination of maintenance when pump is operating or idle. Typical design is shown above.

Mechanical seals have disadvantages, too. They have two faces in rubbing contact on a radial plane. Without adequate lubrication, wear is rapid and failure results. High-temperature boiler feedwater doesn't have good enough lubricating properties on its own. Tight sealing depends upon keeping stationary and rotating faces parallel. Since seals are usually close to the pump bearing, deflection is low. But the angle of shaft deflection is great at this point making it hard to keep these surfaces parallel.

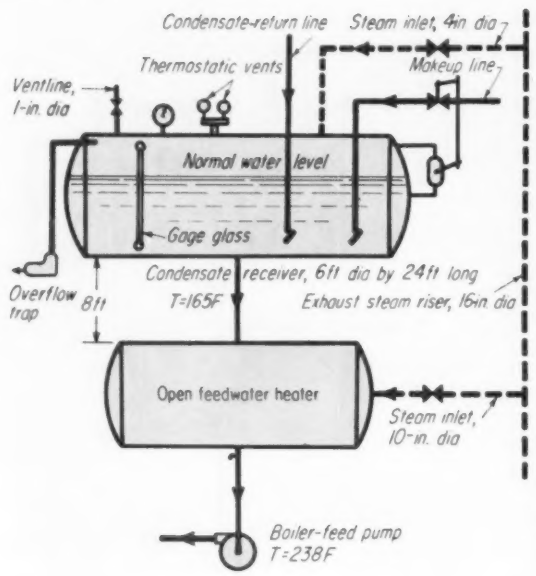
In water-cooled mechanical seals the pump ring forces water out of a pipe connection on top of the stuffing box. An external heat exchanger is often used to cool the water before it is returned to the seal faces through a pipe tap opening in the end plate. If water temperature is 250 F or less, and the pump has a water-cooled jacket, an external heat exchanger isn't necessary.

For best operation, mechanical seals should be used with pumps initially designed for this type closure. It's generally not a good idea to adapt them to high-pressure units originally designed for packed-seal operation.

H B Wayne, *Woodhaven, N. Y.*

**Turn page for new problems ▶**

# More **plant problems** Begins on page 124



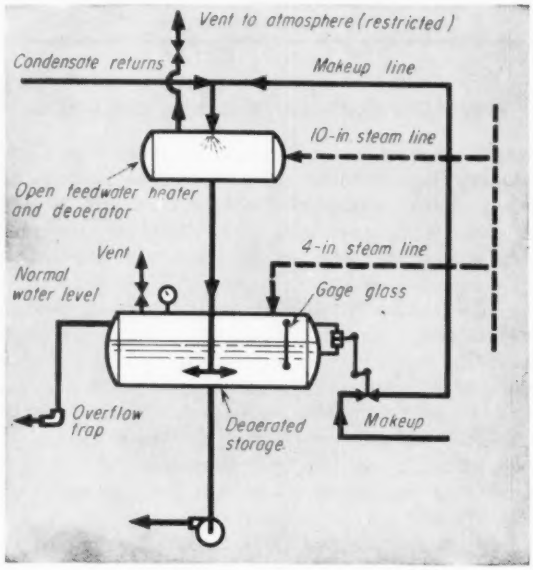

## The problem

## What's wrong with this heater setup?

Above system operates at 9 psi during winter months and 5 psi in summer with less than 1 psi fluctuation. In wintertime, condensate-receiver pressure can drop enough to stop flow to the open heater below. This may happen three or four times a day. But there are also periods of two to three weeks when the system seems to operate smoothly. What can we do to avoid this trouble? Is there a better overall arrangement?—*CZ, April* POWER

**Want some help on plant problems? Send us any of your design and operating headaches. We'll put *Power* readers to work on them**

## The solutions




### This arrangement is much more reliable

It must be realized that the layout used by *CZ* is completely upside down. Best arrangement for a deaerating, heating and feed-pump system is shown above. All condensate and makeup is sprayed into an open feedwater heater. Steam line is sized to heat all water up to saturation. Noncondensable gases are vented to atmosphere. Use of a vent condenser offers heating economy. Discharge line is sized for free flow of heated, deaerated water to the storage tank below. Condensate returns are discharged into the open heater without control. Makeup is added to maintain level in storage tank below.

If we use existing equipment, several revisions can be made to increase system reliability. Any load surge on the boiler-feed pumps, causing drawdown of water storage, is resisted by reduced pressure in the upper tank. Steam shortage at this point is intensified by the extra cooling effect of cold makeup. Increasing the steam line to 10-in. will help considerably.

Since very little storage is available at boiler-feed suction, water level must be maintained at all times. Otherwise free discharge from the upper tank will flood the lower tank at low loads, and starve or vapor bind it at high loads or load surges. Add a level control on the heater to regulate this flow from the upper tank. Also increase the size of pipe connecting the units.

Try discharging both condensate and makeup water into the upper tank above water level. *CZ's* system doesn't deaerate because there's not enough steam for heating. So noncondensables accumulate in the lower tank. Unless there is proper venting from this point the system will continue to malfunction.

J W BISHOP, *Mineola, N. Y.*

## Open heater needs a level controller

It's not surprising that this hookup gives trouble; the most remarkable thing is that it works at all. I assume from the sketch that the open heater is constantly flooded. Usually the upper portion is free for mixing of steam and condensate. Any noncondensable gases liberated are removed by venting.

In *CZ's* case, these gases must work their way up from the open heater to the condensate receiver against the flow of entering water. It's hard to believe any deaeration at all takes place under these conditions.

To correct the situation, I suggest installing a float control on the open heater. This will operate a valve on the heater inlet line to maintain proper water level in this unit. Then add a 4-in. combination vent and equalizing line between the upper space of each tank. Since the condensate receiver is already equipped with a vent, overflow and other connections, these won't have to be duplicated on the heater.

W J STEINERT, *Fresh Meadows, N. Y.*

## Use a larger steam inlet on receiver

I suspect *CZ's* trouble is caused by a sudden increase of condensate flow. Steam is condensed so rapidly in the receiver that the 4-in. supply line can't maintain pressure. With the present arrangement, *CZ* should install a larger steam line to the receiver. Another possibility is to operate the receiver at atmospheric pressure and pump all the condensate to the open heater.

However, the best solution is to start all over and mount the open heater on top of the receiver.

E W MCKNIGHT, *Chapel Hill, N. C.*

## Our heater problem was very similar

*CZ's* heater problem looks very familiar. Our feedwater heater behaved in a similar way. The trouble was caused by too small a steam inlet line to the upper tank (or too small an opening in a manually controlled valve). At light loads, with a partially opened steam inlet valve, the relatively cool water condenses steam faster than it can come in. This gives a partial vacuum, preventing water flow to the open heater. More condensate is then pulled from the lines to completely fill the tank. Steam condensation stops and water pours into the open heater and out the overflow. Then, the cycle starts over again with increasing loss of water.

We solved our problem by adding a large automatic steam-inlet valve on the receiver tank with enough capacity to maintain the desired pressure.

R J SEIBERT, *Seattle, Wash.*

## Try a larger vent on the receiver

We had a similar heating problem. During condensate surges into the receiver tank, the feed pumps would race and almost tear themselves loose from their foundations. Vacuum gage on the receiver registered less than atmospheric every time this happened. By enlarging the vent line, we did away with this pump trouble.

F O PLOTNER, *Phoenix, Ariz.*

# Your July problems

## What steps should we take to avert a furnace explosion?

Our plant has three 30,000-lb-per-hr oil-fired boilers supplying steam for heating and process. Recently, there were several disastrous furnace explosions in our area. Since my operators aren't skilled, I'm afraid we may be headed for trouble, too.

Our immediate plans include conversion to gas, so this seems like a good time to do everything possible to prevent this kind of accident. But, how much safety equipment is needed for a foolproof installation? Is automatic ignition necessary? The controls can't be too complex or our operators won't be able to maintain them. This is a new problem for me and it would help to know what other POWER readers would recommend.—*MH*

## Can we eliminate the 3180-cycle note produced by our generator?

Our plant recently installed a new 700-kw 1800-rpm turbogenerator that is Y connected with the neutral ungrounded. But it produces a 53rd harmonic (3180-cycle note) that interferes with our PA systems, tape recorders, FM radios, etc. By test this harmonic is about 6% of the 60-cycle distortion. The generator has a TIF (telephone interference number) of 40 compared to the standard of 150. So the manufacturer believes the trouble is in our distribution system.

He claims the generator would not produce this harmonic in another network. But it's strange that we don't have the same trouble with our 250-kw 360-rpm generator or our power company tie line. What is causing our difficulty? Can we build a filter that will take very little power and still remove most of this harmonic? Any help readers can give will be appreciated.—*WCR*

**Sit down right now and answer one or both problems. We'll pay extra for answers with photos or sketches.**

# Your page for **comment**

BOB BELLAS, Assistant Editor

## Rockets get most from the least

. . . General Medaris (Major General J B Medaris, Chief, U.S. Army Ordnance Missile Command) expressed the opinion that your article ("Power for space," April 1958, p 84) is very interesting for the nontechnical reader, though perhaps somewhat oversimplified for the technical reader. He stated that the section on energy demand is interesting and thought stimulating.

G L HARRIS, *Public Information Officer*
*Redstone Arsenal, Alabama*

. . . I read it ("Power for space") with much interest, but I must admit that some parts are not entirely clear to me.

In calculating the energy demands, p 188, it was assumed that: (1) The chemical energy of the propellant is converted into mechanical—kinetic and potential—energy without losses and that the result is 100% thermal and propulsive efficiency. (2) This mechanical energy is uniformly distributed in deadload, payload and *total* weight of propellant.

As your article's purpose was to show only the basic principles and problems of rocket launching, your first assumption is perfectly justified. Everybody knows that there are considerable losses in thermal machine operation and the final effect of the losses is that only a part of the fuel energy is converted into useful work.

Referring to your second assumption, however, it's my opinion that the energy from each pound of propellant should be distributed in the deadload and payload and the *instantaneous* weight of the propellant. Let's designate:

$D$ (lb) weight of the deadload and payload of a stage
$F$ (lb) weight of the fuel at any moment
$F_1$ (lb) initial weight of the fuel
$h$ (Btu per lb) heating value of the fuel
$E$ (Btu per lb) energy content of 1 pound of rocket
$E_1$ (Btu per lb) initial energy of 1 pound of rocket

The energy $h \times dF$ developed by the consumption of $dF$ lb of propellant increases the energy of each pound of the rocket by:

$$dE = h \times dF/(D + F)$$

Solution of this differential equation is:

$$E = E_1 + h \times 1n(D + F_1)/(D + F)$$

When the propellant of the stage is burnt out and the shell falls, energy of the payload is:

$$E = E_1 + h \times 1n\,(D + F_1)\,/\,D = E_1 + h \times 1n\,(1 + F_1/D)$$

Using the figures on p 188, for the first stage

$D = 100$ lb
$F_1 = 900$ lb
$h = 6890$ Btu per lb
$E_1 = 0$
$E = 6890 \times 1n\,(1 + 900/100)$
$= 6890 \times 2.3 = 15{,}850$ Btu per lb

The energy of each pound of satellite increases by this same amount for each stage. The difference, $15{,}850/6200 = 2.56$, as compared to your figures may easily be balanced by the poor efficiency of the actual rockets.

GUSTAVE PALOS
*Montreal West (PQ) Canada*

EDITOR'S NOTE: *Associate Editor Ben Skrotzki, who wrote "Power for space," has this to say:*

. . . Mr Palos' thoughtful analysis gives a more accurate picture of the relation between kinetic energy gained by the rocket load and the diminishing weight of the propellant as it burns.

If your calculus is rusty, let's analyze it this way. Assume each pound of propellant lifts a load of 0.1 lb. Arbitrarily divide the pound of propellant into five equal parts with a heating value of $6890/5 = 1378$ Btu each.

The first 0.2 lb of propellant to burn lifts an average of 0.9 lb propellant and 0.1 lb load for a total of 1.0 lb. The last 0.2 lb to burn lifts an average of 0.1 lb propellant and the 0.1 lb load, or 0.2 lb total.

The first part gives a much smaller amount of kinetic energy to the load than the last part. This is the way the energy divides as the 0.2 lb propellant parts burn off:

| Rocket weight | Btu energy release | Kinetic energy gain, Btu | |
|---|---|---|---|
| | | Propellant | Load |
| 1.1 | | | |
| | 1378 | 1240.2 | 137.8 |
| 0.9 | | | |
| | 1378 | 1205.7 | 172.3 |
| 0.7 | | | |
| | 1378 | 1148.4 | 229.6 |
| 0.5 | | | |
| | 1378 | 1033.5 | 344.5 |
| 0.3 | | | |
| | 1378 | 689.0 | 689.0 |
| 0.1 | | | |
| Totals | 6890 | 5316.8 | 1573.2 |

Since the load only weighs 0.1 lb, it gains kinetic energy of 15,732 Btu per lb, very close to the more accurate method of Mr Palos. But then we must allow for losses such as air friction, incomplete combustion, radiation and other variables (more difficult to calculate) which reduce the net gain.

*(Advertisement)*

# Trapping Standardization

## . . . steam trap standardization plus standardized hook-ups spell lower maintenance costs

An important weapon in the fight against rising maintenance costs is standardization. It can reduce the variety of maintenance problems and simplify those which remain.

Since we specialize in steam traps we'd like to offer some suggestions for a trapping standardization program. Such a program involves standardization on one make of trap and standardization of hook-ups.

### Trap Standardization

The advantages of standardizing on a single make of trap are important and can make a big difference in the cost and ease of repairs because—

1. You can carry a more complete stock of repair parts with a smaller inventory.

2. Maintenance personnel has the opportunity to become expert on one make rather than be "jacks of all traps."

3. As an exclusive user of one make of traps you become a preferred customer of your trap representative and can be sure of getting the best possible service.

4. You can enjoy the advantages of standardized hook-ups.

### Standardized Hook-ups

Standardized hook-ups facilitate and reduce the cost of both original installation and maintenance. By adopting standards for the dimensions of all fittings, including nipples, each hook-up for a given size of trap is identical and can be fabricated in the pipe shop.

Unions should be used so that when a trap needs repair, the unions can be uncoupled, the trap lifted from the line and a spare carrying identical length nipples and half unions slipped into place. In as little as a minute or two a faulty trap can be replaced. The faulty trap can go back to the storeroom for repair when convenient and then be put into stock as a spare.

Figure 1 shows a typical standardized hook-up used by a major chemical manufacturer. Note how

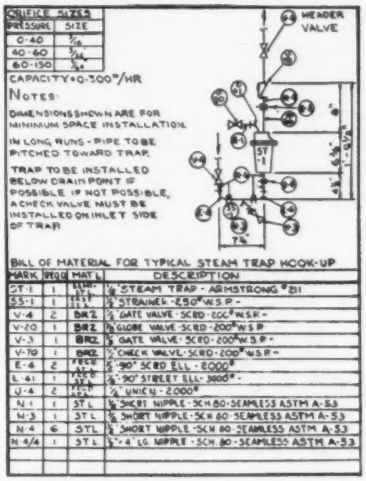



*Fig. 1—Typical standardized installation hook-up used by a leading chemical manufacturer.*

the hook-up provides the following advantages:

1. Test valve in trap cap permits fast, easy checking of trap operation.
2. Strainer ahead of trap protects it against dirt and scale.
3. Blowdown valve in strainer provides easy cleaning.
4. Check valve in discharge line isolates trap when test valve is opened.
5. Shut-off valves and unions ahead of and following trap permit removal of entire trap from line.

Another important consideration for getting the most from a standardization program is accessibility of the traps. Insofar as is possible, traps should be located so that they are convenient for inspection. The easier it is to locate and get at a trap, the less likelihood that it will be overlooked.

*Fig. 2—Armstrong traps have only two moving parts—the lever assembly and the bucket. Nothing much to go wrong here.*

### What Make of Trap? (This is the Commercial)

Obviously, a trap standardization program shows the best results when the make of trap selected is the one that gives the best service. Naturally, we think the make should be Armstrong and fortunately a lot of trap users agree. Here are some of the advantages of standardizing on Armstrong that have been pointed out by these users:

1. *Armstrong traps work.* They don't leak steam and they do discharge condensate and air as fast as they reach the trap. And they work with any return system.

2. *Armstrong traps aren't "prima donnas."* They need no special care or coddling. Valve and seat are hardened chrome steel. Lever assembly and bucket are stainless steel and these are the only moving parts.

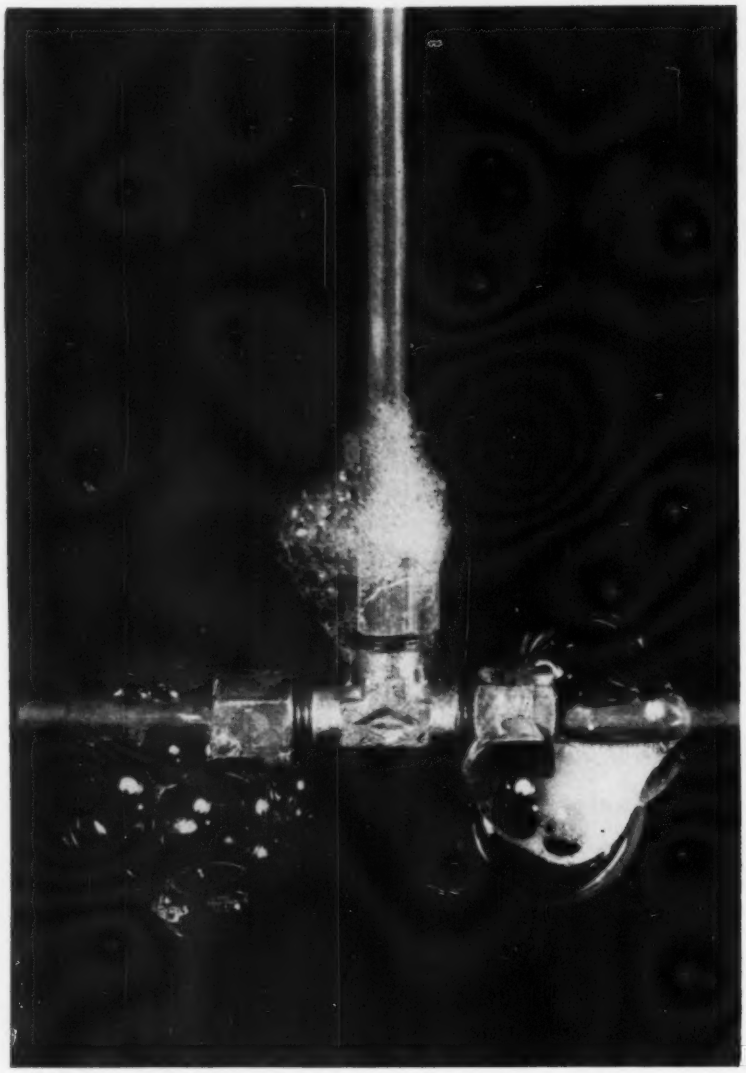
3. *Armstrong traps aren't "orphans."* You can *always* get parts and service from nearby Factory Representatives and stocking distributors.

4. *Armstrong traps are guaranteed.* If you're not *completely* satisfied you can return the traps for refund of purchase price.

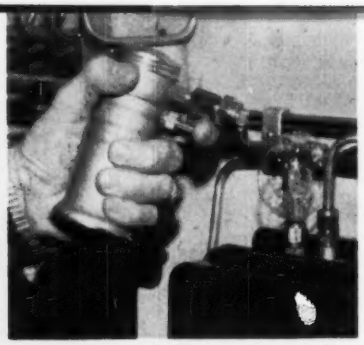
### More Information

The 44-page Steam Trap Book (free on request) gives a lot more facts on trap selection and installation. Call your local Armstrong Representative or write **Armstrong Machine Works, 8127 Maple St., Three Rivers, Michigan.**

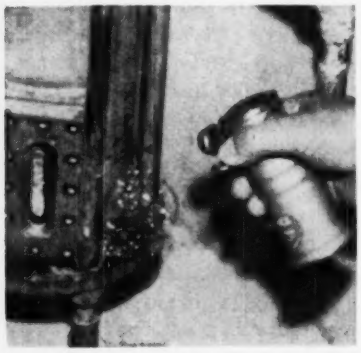
**ARMSTRONG STEAM TRAPS**



**BUBBLES AND FOAM** indicate leaks. Large leaks produce large bubbles; small leaks produce white foam. Spray from one side only since fluid wraps around connection



**PNEUMATIC CONTROL** leaks are found quickly with this finger-pump hand sprayer



**HYDROGEN-GAS** dehydrator leaks show up immediately and last for 30 minutes

**HYDROGEN-COOLED** generator, operating at 35 psi, has small leaks in its jacket

# How to find leaks quickly

Now, you can spray leak-test your hydrogen-cooled generators, refrigeration and air-conditioning equipment, pneumatic lines, controls and panelboards, oxygen lines and cylinders, gas and air lines, tanks and cylinders.

Just spray the surface or connection suspected of leaking and watch for bubble clusters. Large leaks form large bubbles instantly; small leaks form patches of white foam which build up for 30 minutes or more, making detection easy and certain.

This chemical type leak-detection fluid is sprayed on as a clear liquid. There are no confusing suds to give false readings. As bubble producers, chemical type leak-detection fluids are some five times as efficient as soap suds. They work on air and all gases.

Special spray equipment is of two types: (1) A tank spray that holds 3½ gal of fluid for testing large surfaces, and (2) a finger-pump hand sprayer that holds 6 oz of fluid for leak-testing small tube and pipe connections.

Spray leak-testing is safe. Fluids are nontoxic, nonflammable and noninjurious to metals, plastics, rubber, finishes, clothing, shrubbery or the eyes.

—*Courtesy, Winton Products Co, Inc, Charlotte, N. C.*

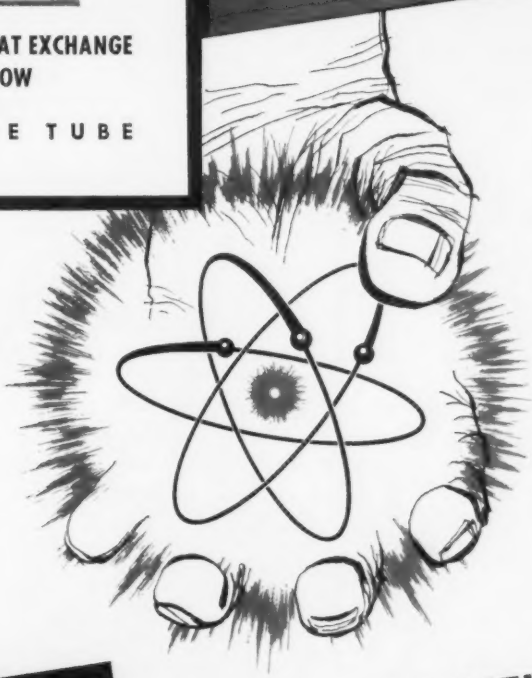
**NOTE:**

**SEND For This Catalog**

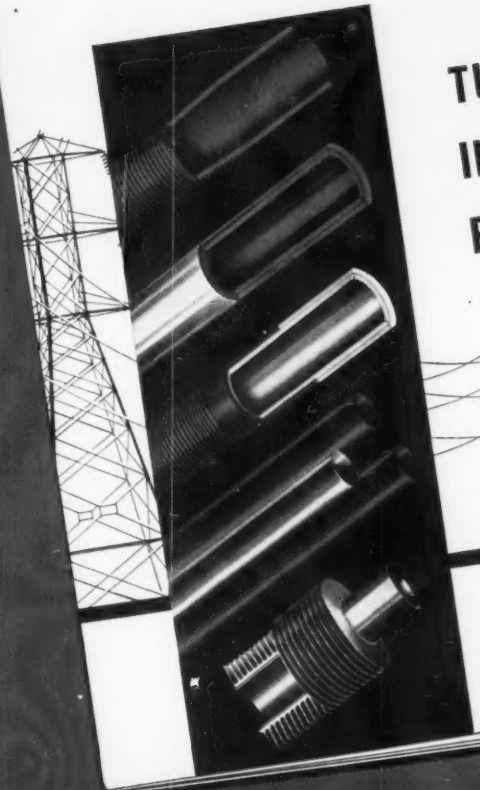
**. . . IT'S FREE!**

**NOTE WOLVERINE HEAT EXCHANGE TUBES BELOW**

**WOLVERINE TUBE**



**TUBING APPLICATIONS IN NUCLEAR POWER PLANTS**



**WOLVERINE TUBE**

DIVISION OF

CALUMET & HECLA, INC.

17268 Southfield Road

Allen Park, Michigan

Manufacturers of Quality Controlled Tubing and Extruded Aluminum Shapes

# Marmy's space ship

When my ex-shipmate Maxwell Marshall, now plant superintendent of the Long Island Lighting Co's new Barrett Station, told me about water washing his boilers with soot blowers, I paid him a visit.

Max is a big easy-going guy who doesn't open his mouth unless he really has something to say. That's a trait we're not all lucky enough to have. But it's a big reason why I always look forward to seeing him. Only this time I'd get an extra dividend for my visit: I'd see his 1,000,000-lb-per-hr boilers being water washed.

Imagine my surprise when I followed Max into the shiny new boiler room and saw none other than Marmaduke Surfaceblow surrounded by several operators. Marmy's erect 6-ft 4-in. frame made him an impressive sight to behold.

The old consulting engineer was quietly puffing away at a piece of rope yarn, while watching the washing operation. The operators standing near him were waiting to answer the cantankerous gent's questions—if any were asked. But as we took in the scene, Marmy just stood there with his hugh fists hooked into the armpits of his checkered vest, and his gray bowler cocked to one side of his massive head. He seemed to be in a trance, just puffing away, watching, but keeping quiet.

As we passed by our hero, Max started explaining to me, "Our problem . . ." but that's as far as he got.

"BILGEWATER on problems," suddenly roared Marmaduke, snapping to life. "I'll tell you guys about the time I cured a lumber-mill headache and all I did was put some picnickers to work with shotguns."

That outburst was unexpected, but highly interesting. So we all crowded around to listen to Marmy's unusual tale. He obliged, as usual, by roaring away in his foghorn voice, looking neither right nor left.

"That's what the trigger-happy picnickers were waiting for," roared Marmy. "They lined up and let go one helluva blast."

"Back in 1923 I was chief engineer on the tramp ship *SS Silver Swallow,*" he bellowed. "She ran from the West Coast to Japan, China, Philippine Islands and down to Siam.

"One trip we were loading lumber at a large lumber mill on Puget Sound before shoving off for Japan. We had just spent two weeks in Frisco Bay overhauling our up-and-down engine, cleaning boilers, building furnace walls and repairing auxiliary machinery. So by the time we got to Puget Sound I figured my gang had earned a good rest before shoving off for those Oriental ports.

"As luck would have it, the mill owner invited us to a company picnic he was throwing for his employees and their families. It was at the mill's private park along the Sound, only a few hundred yards from our ship. There was to be a baseball game, swimming and all the hot dogs and soda pop two hundred people could eat and drink.

"A morning of swimming and diving had me hanging on the ropes, so I navigated over for some hot dogs and other refreshments. The food was served from a big charcoal grill under the trees. Piling my plate high, I pulled up (*Continued on page* 148)

# ONE-SHOT "BOILER TREATMENT" GETS UNEXPECTED RESULTS

## CEMENT MANUFACTURER SHOOTS THE WORKS!

CLEANING rotary cement-drying kilns by firing lead slugs into them to knock off accumulations inside is routine practice. The slugs go bounding and bouncing through the long drying kiln, doing a cleaning job equivalent to a whole crew of pick-and-shovel pilots. No one expects a slug to become so enthusiastic that it continues its chores inside the waste heat boiler attached to the far end of the kiln. In fact, the odds against getting a slug into the boiler *on purpose* are astronomical. But this one got there, odds and all, thus establishing a new type of one-shot boiler treatment which is hardly likely to become popular.

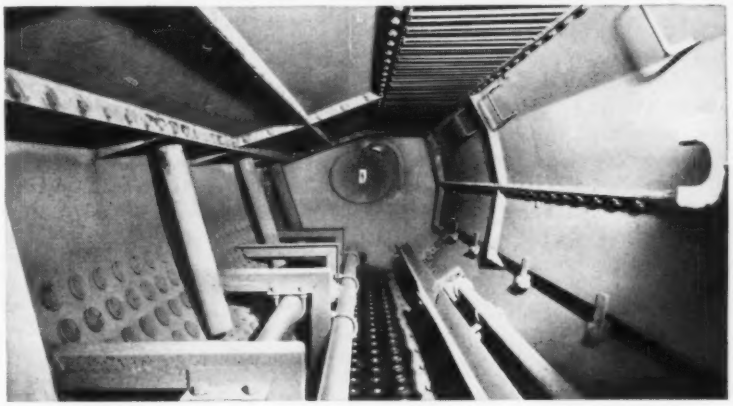
HOWEVER, *inside* the boilers at this large cement plant, Nalco System treatment helps make certain that boiler troubles, if any, are on the outside. Boiler feedwater is aerated, filtered, zeolite softened, evaporated and deaerated. A Nalco corrosion inhibitor is fed between deaerators and feed pumps for corrosion control throughout the steam and condensate return systems. Nalco catalyzed sodium sulfite does the oxygen scavenging on the discharge side of feed pumps. A Nalco internal treatment and caustic soda are fed directly into the boiler for pH control and scale prevention.

It is no wonder these boilers can turn out 169,000 lbs. of steam per hour, year after year, and stay like new—except, of course, for the wayward shotgun slug.

Nalco has not yet developed bullet proofing for boilers . . . But you can never tell what may come next! Meanwhile, we'll be happy to tell you more about effective Nalco Internal Treatment. Ask for Bulletin B1. National Aluminate Corporation, 6222 West 66th Place, Chicago 38, Illinois. In the Northwestern United States, Hawaii and Alaska: The Flox Company, Inc., Minneapolis, Minnesota. In Canada: Alchem Limited, Burlington, Ontario. Branches and affiliates in Spain, Germany and Italy.

**THE TREATMENT:** Lead slug, propelled by heavy powder charge in 8-gauge shell fired from a miniature cannon! "External treatment" with a vengeance.

**THE RESULTS:** "Plugged" boiler tube, pierced by lead slug on the pay off to one chance in a million. Internal treatment powerless here.



Steam drum in one of the Nalco-treated boilers at cement plant is typically clean and corrosion-free when opened for annual inspection.

Water treatment chemical mixing and proportioning room, where Nalco System treatment starts on its way to give complete steam system protection against scale and corrosion.

# Reports from the field

**What's happening in power and what it means to you**

## Transmission voltages rise: is in-plant distribution next?

While nuclear power-generation research goes on, and steam-electric plants grow ever bigger and more efficient, the utility-company man remains painfully aware that each dollar spent for generating facilities will eventually require the investment of 1 1/3 dollars for transmission and distribution. Transmission research has become Project No. 1 with most companies, and they're looking at higher and higher voltages to transmit larger blocks of power cheaper and more reliably.

A 4.5-mile line designed to handle 750 kv will go up next year, as part of General Electric Co's program to gain knowledge and operating experience in the field of extra-high-voltage transmission. The line will be an actual prototype EHV system, carrying power as a part of the Western Massachusetts Electric Co's transmission lines. The right-of-way is 300 ft wide, and towers 158 ft high will be spaced about 1500 ft apart.

Line is scheduled to be energized in early 1960. During the first year it will be operated open-ended for study of corona and mechanical line performance at 460 to 500 kv, later at 600 to 750 kv. In the summer of 1961, terminal equipment will be installed at the open end. Then line will be capable of carrying up to 40 mva at 600 to 750 kv ac. Data from 200 instruments—10,000,000 pieces per year—will go into an electronic data-processing machine. The 5-year project should re-establish the U.S. as a world leader in the EHV field.

Up to 1952, America had the world's highest voltage line, at 287 kv, and we now have 345 kv systems in operation and 460 kv lines under study. But Europe has taken the lead in EHV thinking, primarily because of long distances from generating site

(*Continued on page* 180)

## Power lines

**Nondestructive testing** method for electrical equipment, recently reported to the AIEE, uses dc high voltages to determine insulation strength of rotating machines. Properly interpreted, it can tell more than 1-minute megohmmeter or ac-withstand tests.

**Engineers Joint Council** has been joined by American Institute of Industrial Engineers, bringing total of constituent members to 11.

**Two refrigeration units,** largest and most powerful single, centrifugal chilled-water types ever built, will cool Dept of Agriculture's building in Washington this summer. They will provide 5800 tons of cooling for 2,056,400 sq ft of floor area.

**Geothermal power project** in New Zealand was plagued by terrific noise of escaping steam. Centrifugally spun reinforced concrete pipes with 6-ft diameter installed as cyclonic dissipators ended that headache. . . . Steel constructions for transformer noise reduction work well, can save 20% over masonry enclosures, the AIEE was told.

**Chemical blanket** to save millions of gallons of water lost yearly is being researched by Columbia U. Hexadecanol spreads out on water surface, seals water off from air, reduces evaporation up to 65%.

**Scientific material** currently translated from all languages, including Russian, is indexed by Special Libraries Assn Translation Center. Printed catalog cards cover 12,000 titles yearly, which users can borrow or buy from the Center.

**Largest reheat boiler** in the world, with 550-mw capacity rated at 3,750,000 lb of steam per hr and working with steam at 2400 psi, 1055 F, has been ordered by British Central Electricity Generating Board.

**Mortgage insurance** for industry, like the FHA for homeowners, may be sponsored by government to solve current construction-dollar dilemmas.

**New process** for aluminum-covered steel wire gives a thick, uniform coating for better electrical conductivity. . . . Electrical-grade rubber reinforcing resin offers increased hardness, stiffness, flex life and abrasion resistance. . . . Mineral wool insulates best when covered with reflecting aluminum foil.

**Inter-university corporation** founded by 26 institutions is called Associated Midwest Universities. From headquarters at Argonne National Laboratory, group will boost research, establish labs, see that good students get to work in them.

**Russians** in heavy industry will work 40 hours a week instead of 46 next year. Big catch: pay will be on a piece-work basis, so worker will have to produce his old quota in less time, or have his pay cut.

**Heavy electrical equipment** purchase by U.S. Government from abroad is scored by Allis-Chalmers Mfg Co and General Electric Co. Allis-Chalmers points out that our high-level economy is based on the high taxes and high labor costs that make it hard for U.S. manufacturers to compete with foreign sources. G.E. cites dangers of relying on other countries for supply, maintenance.

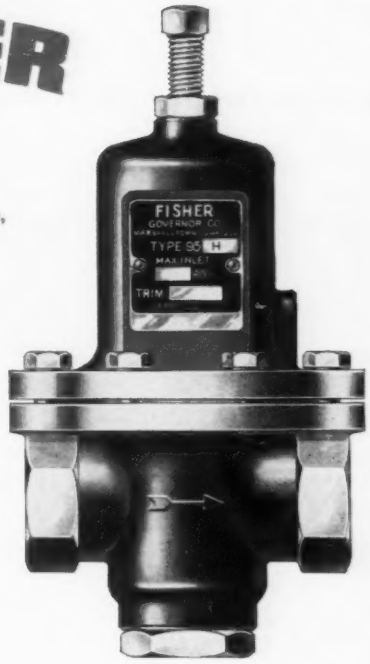
**Scientists are people,** says du Pont's Samuel Lenher. Alarmingly distorted public idea that scientists are unworldly, maladjusted, irreligious must be changed. . . . Research director should bring the humanistic side of life into harmony with science, Dr R G H Siu advises in "The Tao of Science."

For Calendar of Events turn to page 182

# Small Regulator Does Many Jobs!

## FISHER
### TYPE 95

Available in 5 sizes from ¼" to 1" for steam, gas, oil, water and other fluids




**TYPE 95L** with iron body and composition disc or stainless steel trim. For outlet pressures from 2 to 30 psi.

**TYPE 95H** available in cast steel or iron bodies for outlet pressures up to 150 psi.

## Small Size, Large Capacity, Ideal for Limited Space Jobs

As usual, Fisher engineers have packed this small but mighty regulator with a number of outstanding features.

A. **Installation is quick and easy, no external lines, piping or connections.**

B. **Extremely stable because diaphragm is located in isolated chamber out of the flow stream. No fluid velocity impingement possible.**

C. **Positive two-point guiding for stem assures smooth action and perfect alignment.**

D. **Higher capacity results from utilizing downstream pressure through a small registration tube located to produce a velocity boost action. Holds more constant pressure over a wide flow range.**

Another outstanding feature is ready accessibility of all parts. Cleaning or inspection is quickly accomplished with simple tools and without removal from the line. Even the diaphragm may be replaced without disturbing the inner valve or orifice.

**FOR COMPLETE DATA WRITE FOR BULLETIN C-95**

IF IT FLOWS THROUGH PIPE ANYWHERE IN THE WORLD... CHANCES ARE IT'S CONTROLLED BY...

**FISHER GOVERNOR COMPANY**

Marshalltown, Iowa / Woodstock, Canada / London, England

FISHER® Controls

SINCE 1880

# Technical briefs

**Latest engineering developments for busy power men**

9 papers for you on:

HYDRO
ATOMIC POWER
HEAT TRANSFER

### Large pump-turbine installations — U.S. and S. America

| Year | Project | Location | No. of units | Turbine rated hp | Pump rated hp | Speed pump/turbine rpm | Pumping head, ft | Pump discharge, cfs |
|---|---|---|---|---|---|---|---|---|
| 1928 | Rocky River | Connecticut | 1v | 33,300 | 2 at 8100 | 327 | 230 | 250 (*su-pt*) |
| 1939 | Pedreira | Brazil | 1v | 6000 | 6430 | 212 | 81 | 635 (*ru*) |
| 1947 -53 | Pedreira | Brazil | 3v | 18,000 | 18,100 | 138.5 | 81 | 1480 (*ru*) |
| 1950 | Buchanan | Texas | 1v | 10,000 | 13,450 | 164 | 120 | 804 |
| 1952 | Vigario | Brazil | 5v | 22,000 | 22,500 | 167 | 118 | 1400 (*ru*) |
| 1954 | Edgard de Souza | Brazil | 1v | 15,900 | 15,900 | 150 | 78 | 1500 (*ru*) |
| 1954 | Flat Iron | Colorado | 1v | 12,000 | 11,500 | 300/257 | 170-300 | 370 (*ru*) |
| 1956 | Hiwassee | No. Carolina | 1v | 80,000 | 102,000 | 135.9/105.9 | 205 | 3900 (*ru*) |
| 1957 | Sir Adam Beck (Niagara | Ontario Falls) | 6v | 40,500 | 47,500 | 92.3 | 85 | 4100 (*ru*) |
| 1960 | Tuscarora (Niagara | New York Falls) | 12v | 28,000 | 37,500 | 112.5 | 85 | 3400 (*ru*) |

v—vertical shaft unit (*su-pt*)—separate units; pump-motor, turbine-generator
(*ru*)—reversible units

## Pumped storage bids for peak loads

**New opportunities in pumped storage.** *By A J Ackerman, Madison, Wis.*

The overenthusiasts for nuclear power say it will be only a relatively short time until we will have exhausted all hydroelectric potentialities in this country. But they forget the possibilities of developing pumped storage, with the resulting generation of valuable peak-load energy.

In recent years, the growth of interconnected systems has made available substantial blocks of thermal generating capacity for nighttime, or off-peak power supply to large pump-turbine units. Later, during hours of peak load, this stored water is available for driving turbine elements. Thus it returns most of the energy, at a time when it is of much greater value to the system. In some cases this interchange is on a weekly or seasonal basis.

Such opportunities for hydroelectric development are likely to materialize into millions of horsepower of new generating capacity in the future. *APC paper, no number.*

**Pumped storage economics.** *By G R Rich, Chas T Main, Inc*

The combination of steam base and hydraulic pumped-storage may become competitive in those particular cases in which (1) very cheap natural storage is available at moderately high head and immediately adjacent to the main generating plant so as to reduce head losses and the cost of penstocks or waterways (2) the Saturday and Sunday load is relatively very light (3) the weekday peak load is comparatively short (weekday load factor is comparatively low).

The particular province of hydraulic pumped storage comprises all cases in which the base-load power supply is of intermittent duration because of governmental restrictions (as in the case of the Niagara River) or natural laws (as in the case of tidal power plants). The economic advantage of pumped storage is substantially increased by the availability of off-peak dump energy for pumping through system interconnections.

Pumped storage also promises major economies when applied to cases comprising major storage for which the supply is seasonably intermittent, or in which draw-down of the reservoir to provide seasonal flood control storage causes releases to be intermittent. *APC paper, no number*

**Planning for pumped storage.** *By E S Loane, General Public Utilities Corp*

General Public Utilities Corp (G.P.U.) interest in pumped storage has led to investigations of the requirements for suitable sites, the characteristics of pump-turbine equipment, use of pumped storage in system development, its effect on system production costs, and the economic justification for pumped-storage installations. In addition, the company and its subsidiaries have searched for and found a number of very favorable sites for such development in both Pennsylvania and New Jersey.

Of the various schemes studied, one involves a possible joint development of water supply and pumped-storage power at a site where Jersey City proposes to build a single-purpose reservoir. New Jersey Power & Light Co has suggested providing part of the required storage in a second nearby reservoir, at an elevation about 400 ft above the originally planned storage on the Rockaway River. This promises larger storage for the city, lower water costs (resulting from lower property-acquisition costs), removal of certain local objections, and opportunity for economically developing 75 to 100 mw in a location where steam generation or conventional hydro electric capacity would not be at all feasible.

Such dual-purpose developments have been suggested for other New

*News and Notes on...*

# Good Packing Practice

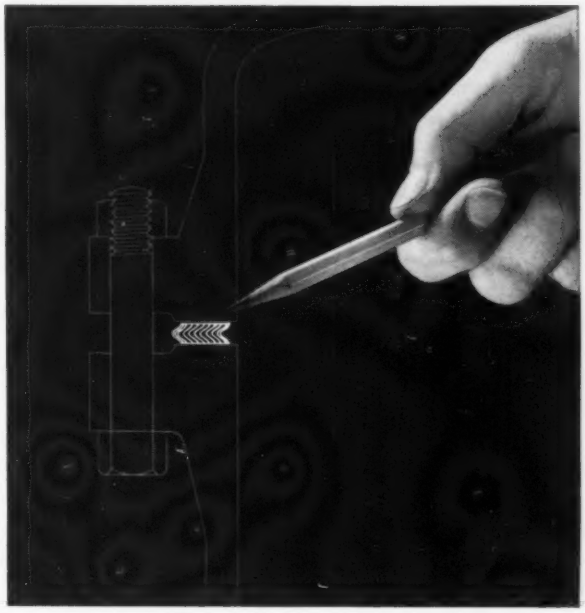
JOHNS-MANVILLE JM PRODUCTS

**Maintenance and Design Hints from Johns-Manville Packings and Textiles Dept.**

## *Subject of the month:* Selecting the Gasket

*Question:*

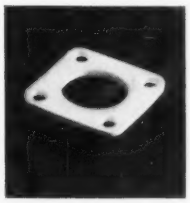
*What are the important points to remember about gasket applications so we can avoid costly failure?*



GASKET engineering is a complex study, but there are certain simple answers to this commonly asked question. Briefly, at least three variables must be considered. These are: 1. The available bolt force on the gasket. 2. Internal pressure and temperature. 3. The nature of the contained fluid.

Starting with bolt force: it must be adequate to flow the gasket material and cause it to yield and seat effectively. Secondly: the bolt force must also always be sufficient to exceed the internal pressure and temperature forces that work against gasket closures. Finally: the gasket material must be impervious to the action of the confined fluid.

**For service at low to medium temperatures and pressures:** As a rule of thumb, if multiplying the operating pressure (psi) by operating temperature (°F) results in a product not exceeding 250,000, a quality "general service" type gasket can be used with complete safety. An outstanding gasket material for these operating conditions is J-M Service® Sheet #60 . . . a tough, durable compressed asbestos sheet. Service Sheet seals effectively against hot or cold water, steam, oils, mild acids and caustics.



**If corrosive fluids are encountered:** The best solution to the constant attack of chemicals and solvents is a gasketing material that is chemically inert. For this kind of service condition, Johns-Manville Teflon* Chempac® Gaskets are recommended. They are available in pure Teflon, low-flow (glass-filled) Teflon, Teflon-Asbestos, and in metal-Teflon combinations.

*TM for DuPont Tetrafluorethylene resin.

**When extreme pressures and temperatures act on the gasket:** If internal pressures reach 1200 psi or temperatures exceed 850°F, safe practice calls for a sturdy gasket that offers the high resiliency needed to follow expanding and contracting movements of flanges. For standard flange applications to 6,000 psi, you will find metal-asbestos, spiral-wound Goetze Spirotallic® gaskets most efficient. They offer high mechanical strength and resilience. Their special interlocking design and stainless steel construction is especially designed to effect and maintain a tight seal despite wide pressure and temperature variations.

**To solve any sealing problems, call your J-M Packings and Gaskets field representative. He's equipped to give you information on new products . . . engineering and design advice. For information on any J-M Packings or Gaskets write Johns-Manville, Box 14, New York 16, N. Y. In Canada: Port Credit, Ontario.**

**JOHNS-MANVILLE**

**100 YEARS OF QUALITY PRODUCTS . . . 1858-1958**

# More **technical briefs**

Jersey sites, but have never been carried out. G.P.U. anticipates no significant interference of one operation with the other. If there ever is interference in emergencies or prolonged drought, power operations will be subordinated to public water-supply requirements.

Paper goes on to discuss the use of pumped storage, required reservoir capacity, effect on production costs, value and cost of pumped storage. *APC paper, no number*

**The electrical features of the Sir Adam Beck - Niagara pumping-generating station.** *By W D Small, Hydro-Electric Power Commission of Ontario*

Purpose of the pumping-generating station is to store the surplus, ordinarily wasted, mechanical energy available at night at Niagara Falls, and turn it to use in meeting daytime peak demands for electric power.

The head developed at Sir Adam Beck-Niagara Generating Station No. 2 is nominally 292 ft, so discharge of the pumping - generating station is available for use at this head. An average of 5.5 kw can be obtained at the pumping-generating station, and 22 kw at Sir Adam Beck No. 2, in return for 7.7 kw in pumping effort, each of these for a discharge rate of one cfs of water.

The pumped-storage reservoir is an artificial lake about two miles long and one mile wide. It provides usable storage of about 15,000 acre-ft. The pumping - generating station consists of six reversible, feathering pump-turbines each connected to a motor-generator. Operating as pumps, these units can discharge 4000 to 5000 cfs under a variable head of 90 to 16 ft respectively, and with an input at the coupling of 55,000 hp. As turbines, these units are rated 40,500 hp under a head of 80 ft, and the discharge varies between 5600 and 4100 cfs with a head range of 80 to 38 ft.

Paper goes on to describe the pump turbine, electrical equipment, and operation of the unit. *AIEE paper, No. 58-794*

*Directions for ordering papers on page 186*

## Atomic power

**Treatment of makeup feedwater, condensate and recycle water for supercritical and nuclear-reactor power plant cycles.** *By V J Calise and J H Duff, Graver Water Conditioning Co*

This paper aims to present a comprehensive view of the experience and practical knowledge as well as the thought and advanced ideas employed in treatment of water in such power plants of the future as the supercritical and nuclear power stations. The authors attempt to show where pioneering engineering and scientific developments are being applied with little practical long-range experience to support them.

Nevertheless the frontiers of power-plant water-treatment engineering are being advanced and they believe that the next few years will show substantial accumulation of actual performance data useful to power-plant designers of the future. *ASME paper, No. 57-A-198*

**Water treatment process for the Dresden Nuclear Power Station.** *By H D Ongman, General Electric Co*

The heat cycle of the Dresden Nuclear Power Station uses a boiling-water reactor operating on a dual cycle. Saturated steam at 950 and 500 psi is supplied to the turbine at separate admission points. The total flow of these two streams is about $2.6 \times 10^6$ pounds per hour. Predicted system corrosion rates are also given in this paper.

Full flow condensate and bypass reactor water demineralization is used to remove corrosion products and other water impurities. A description of the secondary-steam-system chemical treatment is given. *NESC paper, No. 130.*

**Control systems for boiling water power reactors.** *By R N Brey Jr, Leeds & Northrup Co*

As many of the experimental power-reactor types reach maturity and full-scale power plants are built involving the same principles, their operation must integrate into existing power pools. Control systems applied to these reactors must assure economical and safe operation regardless of the particular schedule employed — whether base loaded or carrying load swings as part of system regulation.

This paper outlines a control system for a typical single-cycle boiling-water power reactor. The nuclear and feedwater-control systems are covered. Other methods of flux-level control and steaming-rate control are described. The author briefly mentions the dual-cycle type of boiling-water reactor and its basic control system. *NESC paper, No. 103.*

## Heat transfer

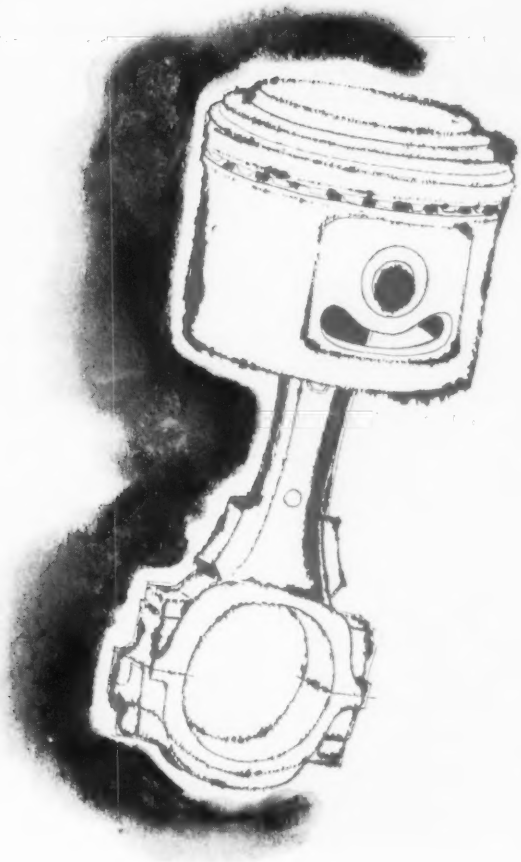
**The effect of flow distribution on heat-exchanger performance.** *By W H Comtois, Combustion Engineering, Inc.*

This paper presents a method for calculating the effect of flow distribution on the performance of heat exchangers when distribution is two dimensional. An exact solution is given for the special case of zero capacity-rate ratio, and an example worked out in detail.

A less exact method, with examples, is given for attacking the problem for any value of the capacity-rate ratio for counter-current and parallel-flow exchangers. A physical reason is presented for the behavior of exchangers operating with flow streams that do not have one-dimensional velocity profiles. Special emphasis is laid on the effect of flow distribution on design of highly effective heat exchangers. *ASME paper, No. 57-A-112*

**Effects of tube bundle-to-shell clearance on pressure drop and heat transfer in shell-and-tube heat exchangers.** *By B E Short and B F Treat, University of Texas.*

The results reported here represent a study of the effect on heat transfer and pressure drop of the clearance between tubes and exchanger shell for a small shell-and-tube heat exchanger. These results are primarily for the laminar-flow region, but some are given for transition and turbulent regions. *ASME paper, No. 57-A-49.*



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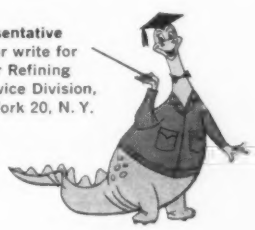

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# Plant equipment news

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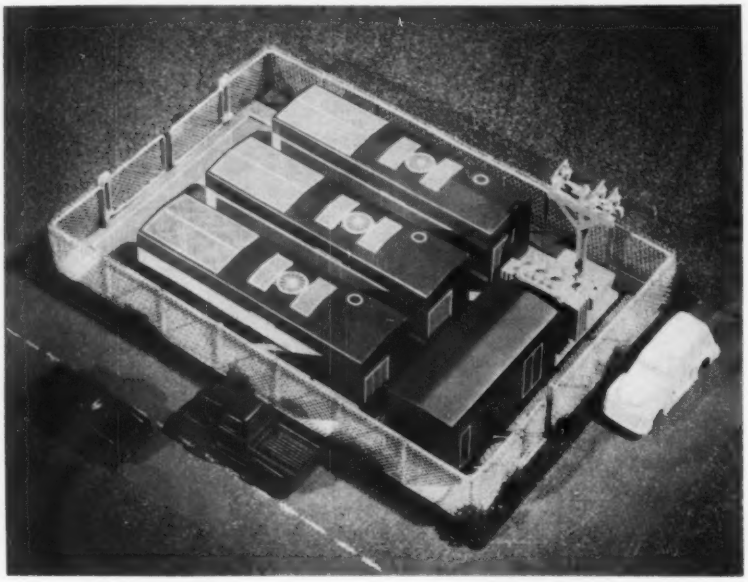


## This 6000-kw package handles peaking, reserve

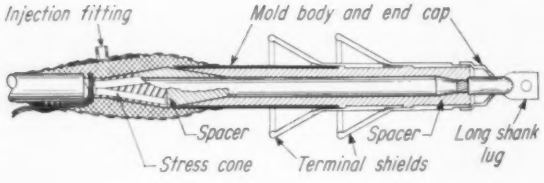
**701** • A portable diesel-powered peaking and reserve plant with 6000-kw 4160-v capacity can now be delivered in four to six months. This "power-block" is made up of three 2000-kw engine-generator units and a centralized electrical control unit, each in a steel weatherproofed sound-deadened housing. Photo, above, shows scale model of the plant.

Generating-control package comes complete, according to manufacturer. All purchaser has to do is provide a base made of concrete or crushed rock and railroad ties, couple the cabling, and set up a fuel tank.

Entire plant with transformer occupies about the same space a small house would need. Sound level is said to be very low, so plant will be a "good neighbor." The packages are designed to operate as unattended fully automatic units supplying full load power into a utility system, and can be brought on-line with all three generators full-load and synchronized in 90 seconds.

Each 2000-kw engine-generator weighs about 50 tons; the control set-up weighs 17 tons. Each unit can be shipped on a standard 40-ft flatcar, and then transferred to a lowboy trailer to be hauled to the installation site.

This plant makes it possible to match load growth as it occurs, according to manufacturer. Since delivery can be made quickly, the utility can afford to postpone installation of expensive facilities and take time to chart needs more accurately, while using this package to provide for peak load growth at a low investment. —*Electromotive Div of General Motors Corp, La Grange, Ill.*




## Predesigning saves time on h-v terminals

**702** • Shielded, high-voltage terminals insulated with epoxy resin can now be made fast and accurately with a method using predesigned terminal shields. These heavy-plastic units are cone shaped, of the interlocking "building-block" type. They are slipped over a plastic tube closed with a stepped end cap to fit various cable sizes.

Each shield is rated at 5 kv. They can be used in combinations up to 15 kv, and are said to give a leakage-resistant exterior suitable for weather-exposed service. Since critical sections are predesigned, identical terminations can be made with a minimum of skill and training, maker states.

The termination is made in five steps: 1. Prepared cable is wrapped with spacer tape to build up a double-ended cone. This is wrapped with aluminum tape to form a stress cone. 2. Cable insulation is wrapped with spacer tape. 3. Mold body with shielded cones is slipped over wrap, pushed down to unshielded end of stress cone. 4. Stress cone is wrapped with a half-lapped layer of expandable plastic electrical tape. A plastic injection fitting is sealed into wrap, then nonexpendable cloth "restrictor" tape applied. 5. Epoxy resin is prepared and forced into termination with a pressure gun.—*Minnesota Mining & Mfg Co, 900 Bush St, St Paul 6, Minn.*

For more data, use post cards, page 145. Identify request with item number.

## CRANE Pressure-Seal Bonnet Valves

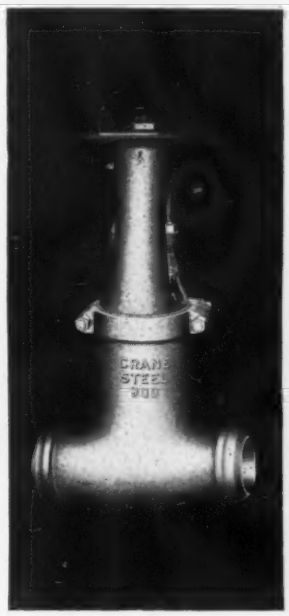
In gate, globe, angle and stop-check patterns—flanged, butt- and socket-welding ends—rated in accordance with A.S.A. in 600-, 900-, 1500- and 2500-pound classes. Sizes: gates—1 to 24 inches; globes and angles—1 to 16 inches; checks—2½ to 12 inches; stop-checks—6 to 12 inches

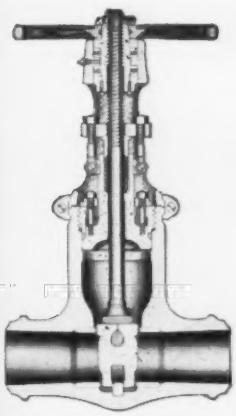
Crane design is at its very best in this streamlined line of pressure-seal bonnet valves—made expressly for high-pressure/high-temperature service in central stations and industrial power plants.

Bonnet joints in these valves are sealed by a unique method which uses *internal fluid pressure* to effect a leakproof seal. This method virtually eliminates bonnet-joint maintenance—and maintenance costs.

Other features include: weight-saving body design—saving up to 60% over conventional design—swivel action yoke and clamp which permits choice of position for motor or gear mechanism . . . one-piece sealing ring . . . Stellited seating surfaces.

Write to address below for descriptive Circular 1936.



# CRANE *high-pressure/temperature valves assure leakproof service—less maintenance*

## CRANE Lip-Seal Bonnet Valves

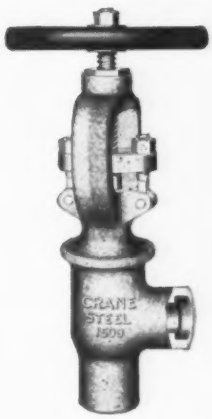
In globe, angle and lift-check patterns; sizes—½ to 2 inches; screwed and socket-welding ends; rated in accordance with A.S.A. in 1500- and 2500-pound pressure classes

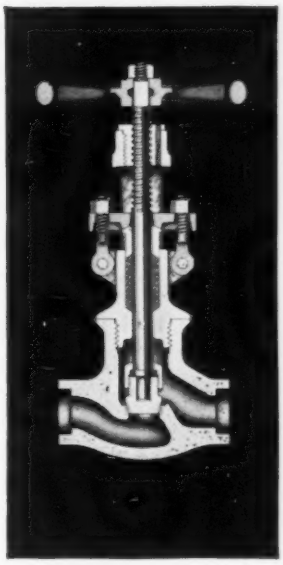
These popular Crane valves are widely used on steam, boiler feed, drips, drains, by-pass, blowdown and similar piping services.

They assure you absolute tightness, no bonnet-joint maintenance, minimum valve weight and bulk without sacrificing strength—and easy, fast dismantling and reassembly.

Features include: lip-seal design which permits re-welding without damage to the valve . . . improved disc-stem connection that minimizes vibration . . . two-piece, non-binding ball-type gland construction . . . and Stellite seating surfaces.

For details, write to Crane Co., for Circular 2099.



***For prompt personal service, see your Crane Representative.***

# CRANE VALVES & FITTINGS

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In Canada: Crane, Limited, 1170 Beaver Hall Square, Montreal, Que.

## Renewable-media filter built to cut corrosion

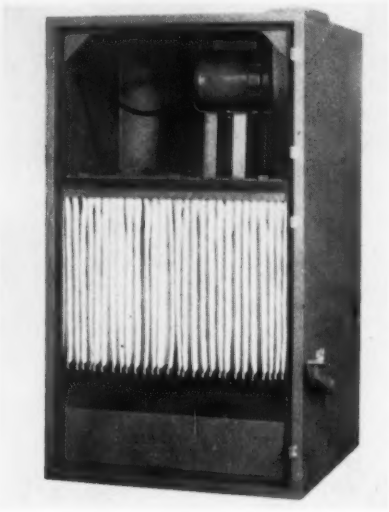
**703** • A standard single-section unit of this air filter fits in six cartons for easy handling. Installation time is cut, storage on the job site is simple, and the unit doesn't require rigging for installation.

The media is reinforced for greater strength, and incorporates an adhesive said to work well in heat, cold and dryness. Unit comes in sections 3-, 4- or 5-ft wide, 5- to 15-ft high. The 65-ft-long glass-fiber filtering media is compressed on a spool to four cu ft, resumes original 2-in. thickness when exposed to the air stream. One roll is an average 12-month supply. The used media, with its accumulated dust load, is rewound on the bottom spool for disposal. Red light signals end of roll.

Unit has galvanized construction to minimize corrosion.—*American Air Filter Co, Inc, 215 Central Ave, Louisville, Ky.*

For details on these items, use post cards p 145. Identify request with item number.

## Woven-cotton filters can handle 600 cfm

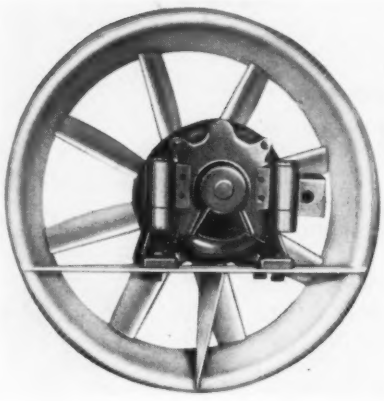


**704** • Improved cabinet cloth-filter dust collector contains 150 sq ft of filters which clean a maximum of 600 cfm of air. The filters are made of fine-woven cotton, and treated to resist sparks.

Maintenance is reduced by a dust-storage drawer with a 2-cu-ft capacity. Drawer is four times larger than in preceding model, according to the manufacturer. The 1-hp motor moves 600 cfm of air through a 4-in. inlet at 4.0-in. static pressure, 400 cfm through a 3-in. inlet at 5.0-in. sp or 350 cfm through each of two 3-in. inlets at 4.0-in. sp.

Cleaned air can be recirculated or exhausted outside. The collector is self-contained.—*Torit Mfg Co, 287 Walnut St, St Paul, Minn.*

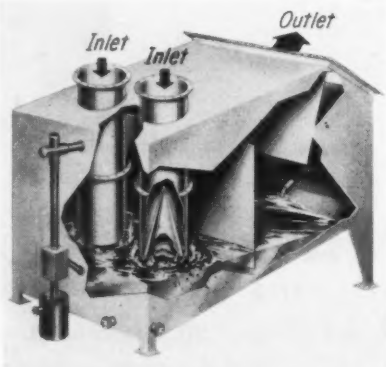
## Fan boasts an aerodynamic blade design



**705** • Direct connected orifice ring fan is used for industrial ventilation, drying and smoke and fume removal. Blade's airfoil design gives uniform air pattern and high pressure characteristic, while keeping the noise level low. The hub is designed to be in equal proportion to wheel surface, according to maker, which eliminates partial stalling.

Aluminum or steel blades are hollow, die-formed in one piece and welded shut. Models with 12- to 72-in. dia come with two, four, six or eight blades.—*Chicago Blower Corp, 9863 Pacific Ave, Franklin Pk, Ill.*

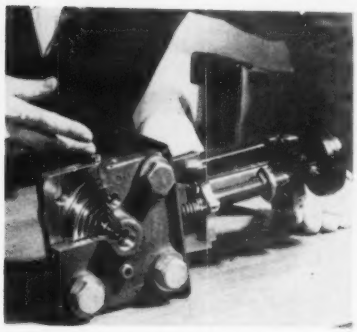
## Scrubber is 97-99% efficient




**706** • Unit operates by impinging dusty gas at high velocity into a pool of scrubbing liquid. Fast impingement causes gas and dust to penetrate deeply into the liquid bath, so that collection efficiency is high—even when particles are in the fume range, manufacturer states.

Unit has a pressure drop of five to ten in. of water, and the liquid ratio is one to five gpm per 1000 cfm.—*Western Precipitation Corp, 1000 W Ninth St, Los Angeles 54, Calif.*

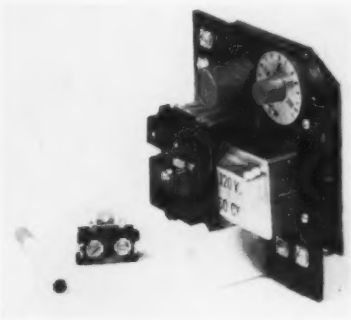
Begins on page 140



## Dp transmitter is made for flow, liquid-level use

**707** • Differential-pressure transmitter has an accuracy established at 1% of range span. Damping is built in at measurement source, and distortion due to outside forces acting on the cover is said to be eliminated. Static pressure effect is less than 0.2% per 100-psi change.

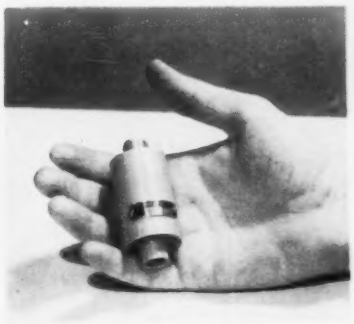
The unit has a range adjustable between 20 and 200 in. of water, and suppression up to 100 in. on either high or low pressure side.—*Mason-Neilan, Nahatan St, Norwood, Mass.*



## Temperature-control system has many applications

**708** • System consists of a compact transistorized amplifier (the temperature controller) and a vibrationproof mounting containing a thermistor (the sensing element). Thermistor mounting and amplifier relay can be up to two miles apart.

System controls air, surface or immersion temperatures. Amplifier relays come in ranges covering –60 to +520 deg.—*Minneapolis-Honeywell Regulator Co, Control Device Div, 2747 4th Ave S, Minneapolis, Minn.*

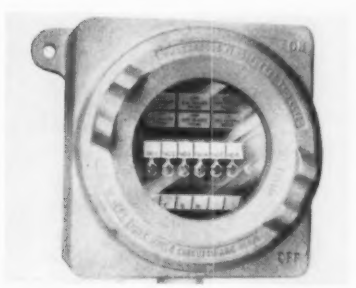


## Pressure switch used with air, oil, gas at –65 to 250 F

**709** • Low-cost general-purpose pressure switch is of aircraft quality. Unit weighs only 3½ oz; covers pressure ranges from two to 3000 psi.

The switch is 1⅜ in. in diameter, 2⅞ in. long. It is suitable for use with air, gas, oil or fuel. Minor changes in setting can easily be made in the field, maker states. Switches are designated 6607-1 to -9.

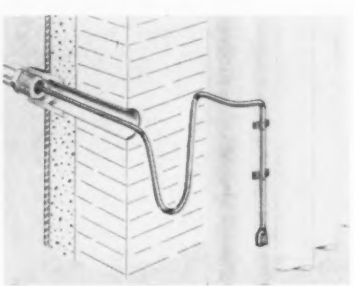
The unit is built to take temperatures from –65 to +250 F.—*Consolidated Controls Corp, Bethel, Conn.*



## Miniature annunciators are explosionproof

**710** • Compact 6-alarm-point unit meets Class 1, Div 1 requirements. It is suitable for remote locations, where source of trouble must be identified and recorded. Unit has a static switching circuit containing silicon diodes and thermistors.

Housing of unit, designated *STEM*, measures 6x6½x7 in.—*Scam Instrument Corp, Scammit Div, 1811 W Irving Pk Rd, Chicago, Ill.*



## These thermocouples save 75% on installation time

**711** • Furnace tube-wall thermocouples can be installed in 25% of the time needed for conventional models because they are made of ceramic-insulated conductors cased in metal sheathing, maker claims. Units can be bent, and will flex with the differential motion between tubes and wall. They have an OD range of 1/16 to 7/16 in.—*Thermo Electric Co, Inc, Saddle Brook, N. J.*

**Don't miss this item . . .**

**Chronograph-slide rule** . . . p 174

**. . . or other product news appearing on following pages**


**Manual starter** . . . . . p 174
**Color-coded packings** . . . p 174
**Hot-gas washer** . . . . . p 176
**Flexible lacing** . . . . . p 176
**Packaged boiler gage** . . . p 178
**Compressor ball valves** . . . p 178

George Edwards

## believes more kids would take chances–if they had 'em

In Putnam City, Oklahoma, last March, James Briscoe cracked the throttle on a turbine-generator while his twin brother John carefully watched the water-gage glass on a newly erected watertube boiler. James brought the unit up to speed and closed a switch. As lights flashed on in the room, the brothers grinned at each other and, reaching across the top of the boiler, shook hands.

Reaching across the boiler wasn't much of a problem because the entire steam plant was built on a table top. And the Briscoe brothers, a couple of 14-yr olds, had designed it from start to finish. Entered as an exhibit in their junior high school's annual science fair, it took top honors.

At the outset of this ambitious project, James and John asked for, and quickly got, permission from Combustion Engineering, Inc, to copy its boiler design. Poring over the ASME *Power Boiler Code*, the kids calculated head and shell thicknesses, ligament efficiencies and everything else needed to determine the boiler's maximum allowable working pressure. A local consulting engineer's office donated drawing paper. A boiler shop, a plumbing and heating outfit and a welding contractor contributed some of the needed materials and did the critical welding. After finishing the boiler, the boys built a condensing turbine and tied it into the system. Then, with the turbine driving a small generator, they were in business. Altogether, they put about 750 man-sized boy-hours into the project.

Their project report, neatly typed and complete down to the last material spec, calculation detail and nickel spent, leaves no doubt that they knew what they were doing. My guess is that their report is guilty of a mild understatement in saying: "The construction of this boiler was not an easy task as the proper tools were not available."

I don't believe for a minute that James and John think of themselves as boy wonders. They're mighty proud of their project, and rightly so. But they're normal American kids who've got a lot on the ball —*and got a chance to demonstrate it.* Just like the hundreds of other youngsters in their age bracket who are doing some fine work in electronics, biology, astronomy and other fields.

How much potent brainpower we'd uncover if we uncorked a real effort to find it in our teenagers is anybody's guess. Mine is that we'd quit worrying about the output from the Soviet Union's technical schools.

We're making a move in this direction. Some engineering management people working with high-school science departments have proved what can be done. If more people in industry would promote "talent-hunt" programs we'd not only build a reservoir of gray matter that we're going to need badly, but we'd go a long way toward wiping out a situation that's causing people to say "You never see a teenager's picture in the papers these days without a cop holding him by the scruff of the neck."

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### WATER TREATMENT

1 **Scale remover,** other products for use in evaporative condensers, cooling-tower systems are covered in 8-p brochure. Includes acid, corrosion inhibitor. Calgon Co, Micromet Dept, Hagan Bldg, Pittsburgh 30, Pa.

2 **Internal self-purification** of feedwater and condensate is topic of 8-p technical reprint T-157. Discusses use of a scavenger-demineralizer system in boiler-turbine cycle. Graver Water Conditioning Co, 216 W 14th St, New York 11, N. Y.

3 **Water conditioning** equipment — softeners, mixed-bed and multicolumn deionizers—is subject of 20-p bulletin 611C. Illustrated with photos, diagrams, cutaway drawings. Elgin Softener Corp, 130 N Grove Ave, Elgin, Ill.

4 **Modern water treatment** is subject of 12-p booklet 4433. Book is said to be a basic refresher course on industrial and boiler-feed water. The Permutit Co, 50 W 44th St, New York 36, N. Y.

5 **Water-analysis** procedure, test kits, apparatus and chemicals are covered in 48-p catalog 5. APHA standard methods are included in discussion. Hach Chemical Co, Ames, Iowa.

### WELDING

6 **Welding-wire guide** is 84-p booklet ADC 873. Contains sections on chemical composition, mechanical properties, operating procedures, as well as varieties of wire types, diameters. Air Reduction Co, Inc, Air Reduction Sales Co Div, 150 E 42nd St, New York 17, N. Y.

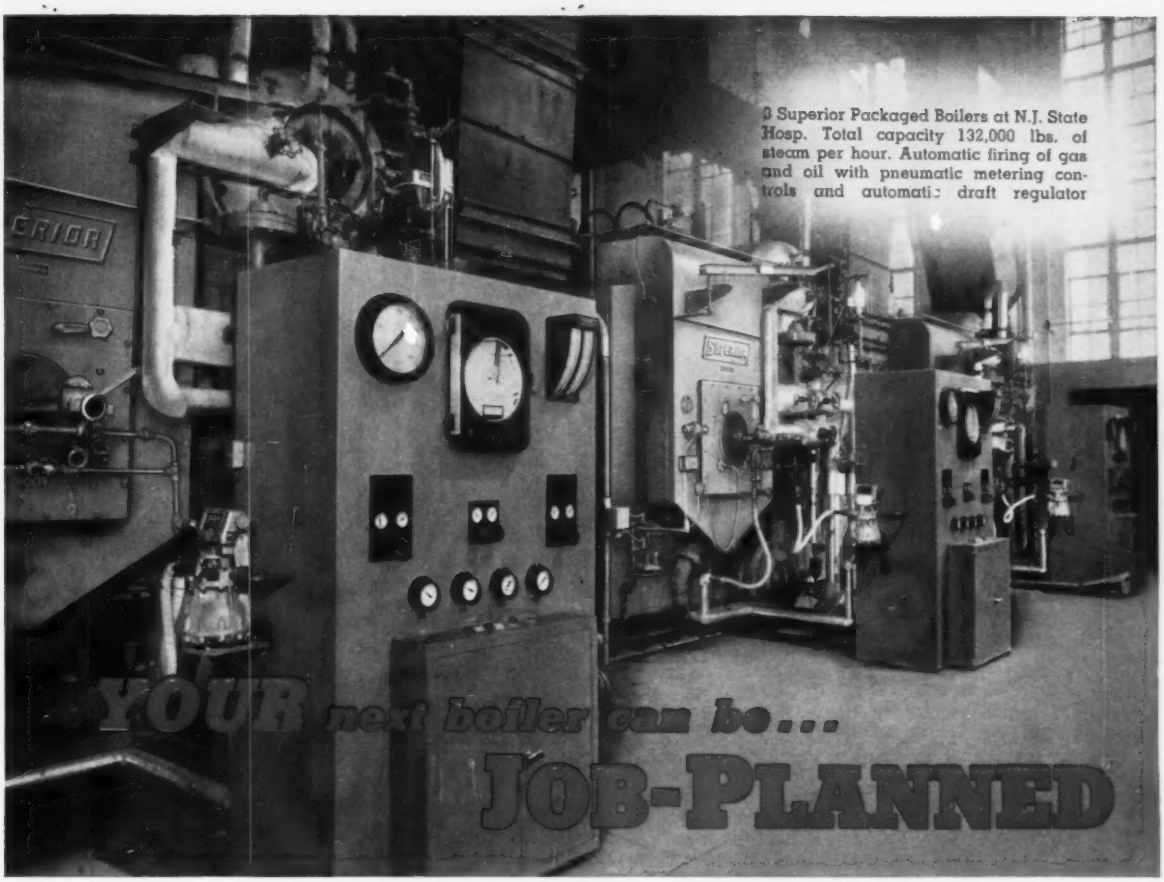
7 **Submerged-arc welder** is subject of 6-p bulletin 5205.1. Includes "how-to" photos. The Lincoln Electric Co, Cleveland 17, Ohio.

8 **Supplies, accessories** are listed in 48-p catalog 9-13. Covers all types of welding rods, fluxes, brazing alloys, safety gear. Air Reduction Co, Inc, Air Reduction Sales Co Div, 150 E 42nd St, New York 17, N. Y.

### PRIME MOVERS

9 **Combustion gas turbines** ranging from 4750- to 21,800-kw capacity are discussed in 24-p booklet GED-3603. Includes cross sections, schematic drawings, cutaways, installation photos. General Electric Co, Schenectady 5, N. Y.

10 **Gas engines,** 4-cycle V-angle models in hp ranges from 220 to 1760, are described in bulletins 10051, 52, 53. They include specs, diagrams. Ingersoll-Rand Co, 11 Broadway, New York 4, N. Y. (*Continued on page* 166)


3 Superior Packaged Boilers at N.J. State Hosp. Total capacity 132,000 lbs. of steam per hour. Automatic firing of gas and oil with pneumatic metering controls and automatic draft regulator
YOUR next boiler can be...
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Capacities to 50,000 lbs. per hour.
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Electric position (parallel) combustion controls.
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Separate packaged economizers.

All this with undivided responsibility, guaranteed performance and efficiency for minimum maintenance.

Why not choose your "guaranteed" packaged boiler to meet the needs of your job, just as you would when specifying a field-erected plant, and still get the advantages of factory assembly, factory-fire-testing, and most important, undivided responsibility?

The Superior Packaged Boilers pictured here are "job-planned" units incorporating burner and control equipment as specified by the purchaser, and tested at actual working conditions before shipment.

Testing involves all functional equipment: forced draft fan, burner, combustion controls, programming equipment, etc., mounted or connected to the boiler, thus providing a guaranteed product with undivided responsibility. Why settle for less? Why purchase half a package? For details write for Catalog 1000-W.

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SUPERIOR
PACKAGED BOILERS

# RAMBLINGS ON INSTRUMENTATION

## Happy Birthday, Dear British Thermal Unit!

The British Thermal Unit is 177 years old this month. In today's chaotic world it is indeed comforting to find this doughty old symbol standing virtually alone in its field[1], unchanged, unchallenged, a thermal Rock of Gibraltar in the turbulent seas of science. (Knowledgeable engineers have long recognized that the common calorie simply lacks the class of the BTU.)

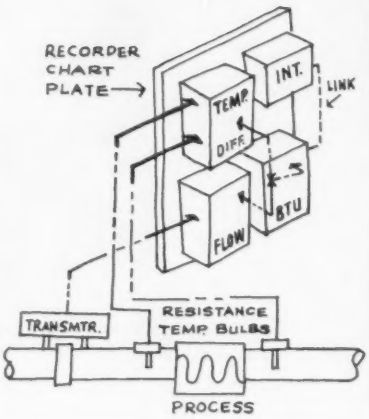
Between crumpet breaks in Hays' internationally oriented engineering department, we have prepared a fitting birthday tribute to jolly old BTU—the Hays Mark VII, (by special arrangement with Jack Webb) BTU recorder.

This indefatigable Boswell of the BTU provides a highly accurate diary of thermal behavior—and misbehavior—in water flow and other applications. Using a remote flow transmitter and resistance temperature bulbs, it produces *linear* records of flow, Delta T and BTU, plus integration of BTU.

More good news for you dyed-in-the-wool BTU buffs is the fact that all operating elements are mounted with grim determination on the ¼" cast aluminum chart plate, which has two-point suspension to prevent those deplorable shifts in readings due to mounting of the case on uneven surfaces. The sketch above, prepared by our draughting loft, may or may not clarify all this.

In operation, the product of temperature difference and flow is fed to the BTU receiver unit. The continuous mechanical integrator is loaded by this unit through linkage to provide a necessary total of BTU.

[1]The British have not always had the thermal unit field to themselves, of course. The Texas Thermal Unit, developed during the Civil War, eventually proved too unwieldy for use elsewhere. There was also the "America-First" Thermal Unit, sponsored by a clique of midwestern Anglophobes, which won brief support in the early '20's. Drop these informative tid-bits into a conversational lull sometime and watch the admiring glances.




*Faithful Boswell of the British Thermal Unit, the Hays Mark VII BTU Recorder.*

Less than $1,800 will put one of these recorders in your plant, office or bath. Comes complete with temperature resistance bulbs, orifice plate and leather carrying case. We pay postage. Do your bit for Anglo-American relations. Get to *know* your BTU's. Buy a Hays Mark VII BTU Recorder.

Reading about the Universal recorder is no substitute for the real thing, of course, but if you prefer your thrills vicariously, write for Hays bulletin 58-1240-137. Most illuminating.

## . . . And For The Colonies . . .

Realizing that not everyone has real imported BTU's in their pipeline, we have designed the Universal recorder to cope with practically any other application of a cruder nature. We would, as they say in the States, like to give your unusual recording problem a whirl. Why not drop me a line with the details?

Phil A. Sprague

President

THE HAYS CORPORATION • MICHIGAN CITY 3, INDIANA


## Marmaduke

*Continued from page 132*

at a nearby table where the plant super and his gang were busy loading their holds.

"'You marine engineers sure have an easy life,' kidded the super. 'You're in a new port every day with a different girl waiting for you. Not only that, but you don't have the tough mechanical problems that dog us in a lumber mill.'

"'Like what?' I asked, giving him a fishy look.

"'Like this,' spoke up the master mechanic through a mouth full of hot dogs. 'Right now I've got to inspect the inside of our brick smoke chimney. She's 200 feet high, and I can't even find a way to get up there.'

"'Why not?' I asked.

"'Why not?' he echoed. 'Because the iron rungs on the outside of that chimney are rusted so badly my conscience won't let me send anyone to her top. But we got to get a man up there so we can anchor a hook for a bosun's chair. Then our man can lower himself inside the stack to make the inspection.'

"'We could build a scaffold around the chimney,' cut in the super, 'but that's expensive.'

"'We'll have to,' came back the master mechanic, 'because the insurance company won't renew our contract without an inspection.'

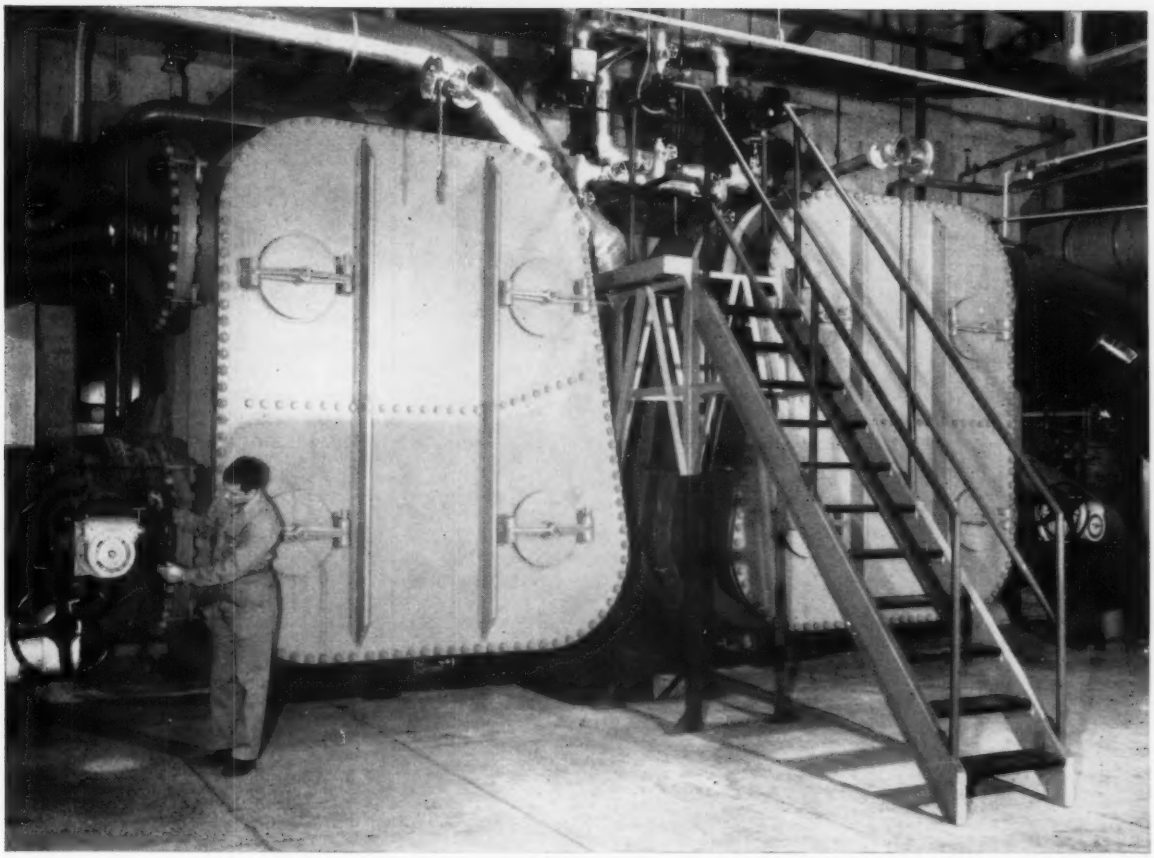
"'Let's get this right,' I cut in. 'You've got a 200-foot brick chimney. You have to inspect it from the inside, but you can't do that because the iron rungs on the outside are so badly rusted that you can't send a man up there to suspend a block and tackle for a bosun's chair.'

"'That's the problem in a nutshell,' said the super. 'That's what I mean by problems in this business. You marine guys just don't have our headaches.'

"'You're absolutely right about not having headaches with brick chimneys aboard ship,' I answered. 'But I'll bet any smart ship's engineer can get that hook up there for suspending your bosun's chair. And I'll bet he can do it without building a scaffold.'

"That remark caused plenty of ears to perk up. People from nearby tables started to crowd around us.

"'How you gonna get up there, sprout wings?' jested the plant owner



*Consulting Engineers, Gibbs & Hill*

# PLUS PERFORMANCE FROM YUBA CONDENSERS

Performance tests made by the Indianapolis Power & Light Company on this 50,000 sq. ft. Yuba surface condenser a year after it was installed in their H. T. Pritchard Station showed zero oxygen content in the condensate. The temperature of the condensate was found to be 3.9 degrees higher than the temperature corresponding to saturation pressure. Heat transfer was 106.6% of design.

Magnificent performance such as this is far in excess of guarantees and it proves once again that there are great plus values in Yuba equipment.

Consult Yuba for advanced condenser design and manufacture. Yuba condenser designs can save plant space, as well as initial cost for foundations and piping. A de-aerating section within the condenser shell eliminates the main plant de-aerating heater.

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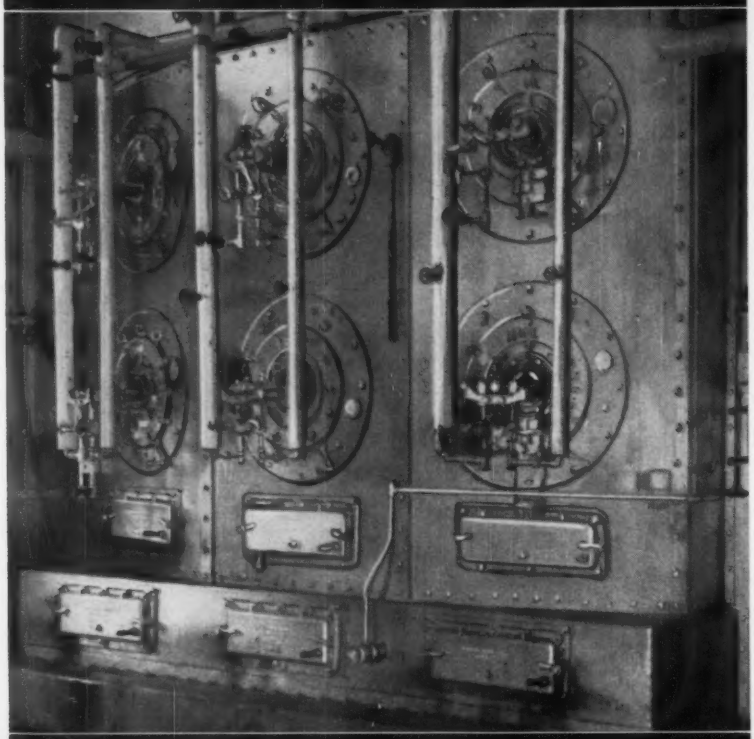

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**OIL BURNERS**

. . . you get better performance, more economical combustion with NATIONAL AIROIL Universal Registers because they have a dual feature for controlling air volume independent of turbulence. Air vanes can be instantly reversed to change direction of turbulence while air volume is separately regulated by a refractory faced disk control. Both adjustments can be made while the Type "S-A-L" Oil Burner is firing.

Another "dual advantage" of NATIONAL AIROIL Universal Registers is that they are equipped for dual fuel firing of gas and oil.

Universal Registers with Type "S-A-L" Burners are available in three (3) sizes . . . capacities up to 60,000 lbs. of steam produced per burner per hour. Write for Bulletin 51.

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*Main Office & Factory:* **1250 EAST SEDGLEY AVE., PHILADELPHIA 34, PA.**

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## Marmaduke

*Continued from page 148*

good naturedly. 'Or will you shoot someone out of a cannon?' Everyone laughed at the boss' joke, but I kept quiet.

" 'No,' I answered finally, looking him straight in the face. 'I'll use a balloon.'

" 'Balloon!' piped up the master mechanic. 'Now where in hell are you gonna get a balloon in this part of the country that's big enough to take a guy up 200 feet?' That got another round of guffaws.

" 'Right there,' I answered, pointing to a couple of kids with toy balloons.

" 'Look chief,' said the owner earnestly. 'This is a serious matter. We can't get to the top of that chimney. The insurance company insists on making the inspection, but it can't be done with those corroded rungs. So, this is no time to be kidding around.'

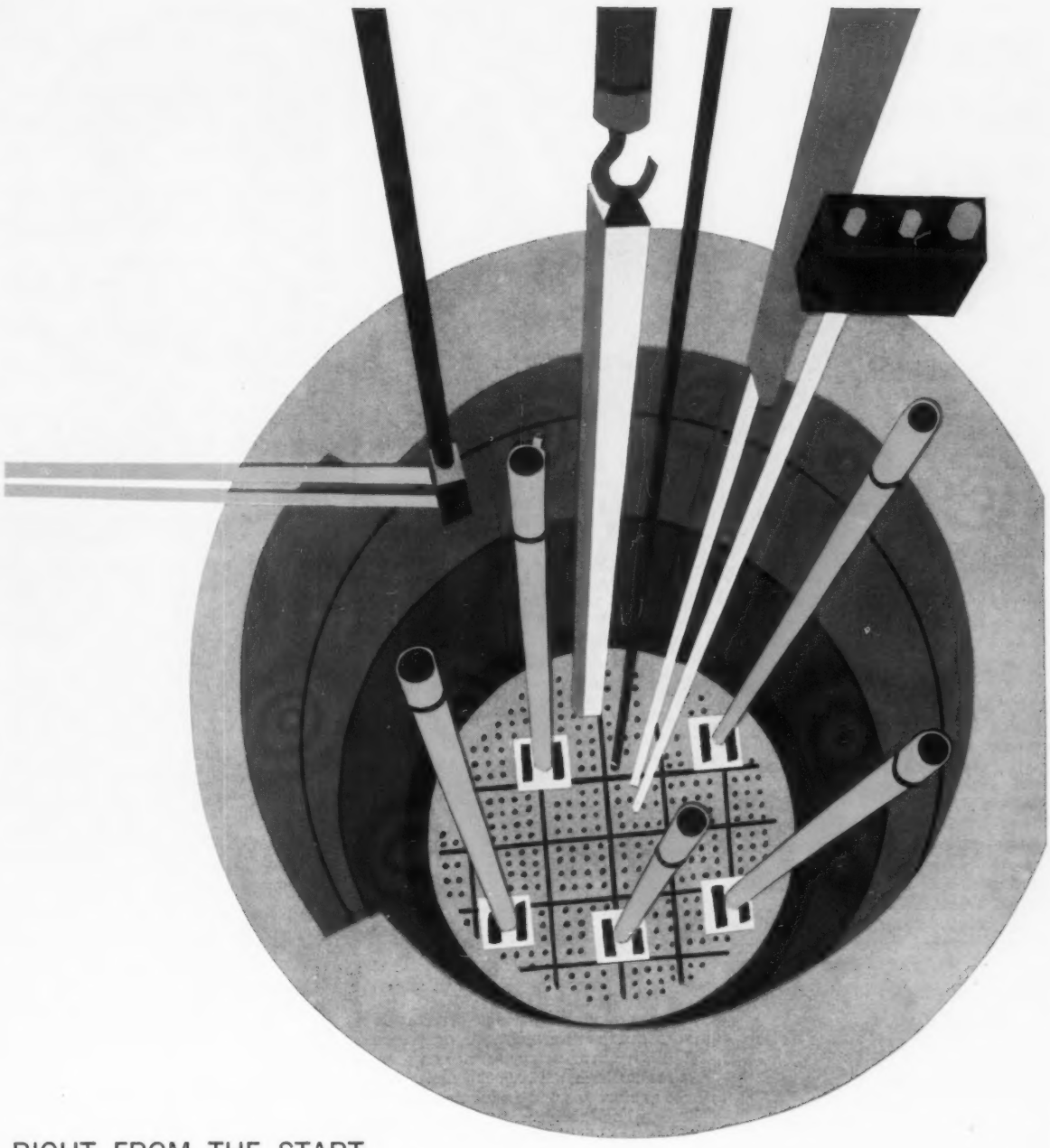
" 'I'm not kidding,' I assured him. 'You boys have been so nice to us today that I'm going to get a bosun's chair up there for you. And I won't lift my feet off the ground to do it,' I said. 'But I'll need a few things to do the job.'

" 'That's mighty nice of you,' answered the owner after he saw I meant business. 'But I hope the few things you need won't be impossible for us to supply.'

" 'Let's go over to the smokestack right now,' I told him. 'How about sending someone for a shotgun. Get several reels of fishing line, and a half-inch steel nut. Then leave the rest to me.'

"When the boys and gals heard I'd need a shotgun to get that bosun's chair to the top of that stack, some wild rumors started to fly. 'He's gonna shoot that thing up there,' I heard someone say. Then half a dozen guys scooted home on the double to get their guns. Before long, all the picnickers were gathered around the stack. Talk about a circus!

"With everyone watching, I took four balloons out of my pocket that I had gotten from the kids at the picnic. Handing them to the master mechanic, I asked him to inflate them with illuminating or acetylene gas. Then, taking the several reels of fishing line, I tied the four balloons and the half-inch steel nut to one end. Stepping inside the stack's cleanout



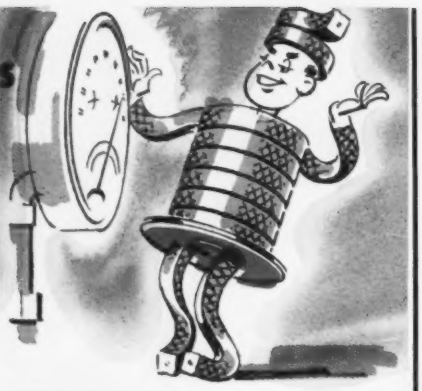
## RIGHT FROM THE START . . .

When piping costs come close to the million mark — when the installation is vast, and the leeway for error is small — a piping job must be right from the start to finish. Grinnell assures this through complete one-company control and responsibility. From interpretive engineering — through exclusive methods of prefabrication and testing of pipe and hanger units — to precision assembly and delivery, the job is all done by Grinnell, as only Grinnell can do it. The result: installations of any size, at costs known before you start, with assured performance. Grinnell Company, Inc., Providence, R.I.

Current Grinnell piping responsibilities. Enrico Fermi Atomic Power Plant, Michigan; Ohio Power Company, West Virginia; National Aniline Division of Allied Chemical & Dye Corporation, Virginia; Memphis Light, Gas and Water Division, Tennessee; Aluminum Company of America, Indiana; South Carolina Electric & Gas Company, South Carolina; Duke Power Company, North Carolina; Union Bag-Camp Paper Corp., Virginia; Pennsylvania Power & Light Company, Pennsylvania; Holyoke Water Power Company, Massachusetts

**GRINNELL**

Where Temperatures and Pressures "GET HIGH"

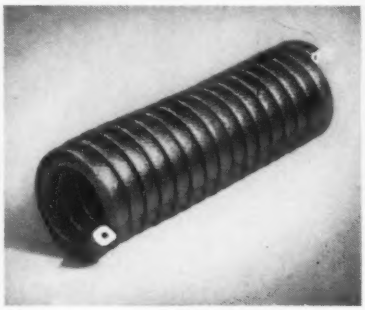


...you need these packings!

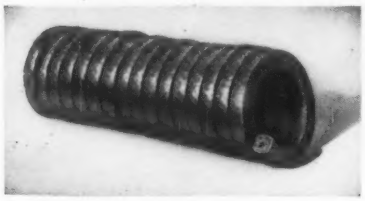
**Style HP-2M**—excels against severe temperatures and pressures. A braided asbestos packing reinforced with a monel wire insertion. For use on centrifugal and reciprocating pumps, valve stems, expansion joints, etc.

**Style No. 30** – a very dense braided asbestos packing, highly resistant to high pressures. For use against petroleum products at high temperatures and pressures.

**Style HP-RC** – a wrapped asbestos cloth packing with a resilient rubber core. For use on steam hammers, expansion joints, pumps and piston rods calling for high pressure steam, air and gases at temperatures to 600 degrees F.



**Style HP-RB**—for high pressure steam service up to 600 degrees F. Constructed with a core of accordion-folded asbestos cloth and a resilient rubber back, around which is wrapped a closely woven asbestos cloth jacket.



**Aquapak Hydraulic Packing** – a semi-metallic packing designed to withstand severe hydraulic pressures. Will give satisfactory service on pressures as high as 10,000 pounds. For use against hot and cold water on centrifugal and reciprocating pumps, outside packed boiler feed pumps and similar equipment.

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## Marmaduke

*Continued from page 150*

door, I floated these balloons up and out of the chimney. There was a light breeze blowing so the balloons were blown away from the stack.

"After all the fishing line was paid out, I gave the command for the trigger-happy boys to shoot. That's what they were waiting for. They all blasted away at once to see who could wing those balloons first.

"One salvo and those balloons were dead ducks. The nut brought down the end of the fishing line like Haley's comet shooting towards earth.

"'Now tie a heavier cord to the end of this line,' I told the master mechanic, 'and pull it up with the fishing line. Then, tie on a rope that's strong enough to support your man up there. Attach the bosun's chair with the block and tackle to it and pull it up. Anchor the end of the rope to something outside the stack and you're in business.' And that's exactly what they did.

"Inside an hour that bosun's chair was ready for the inspector. So before the *Silver Swallow* shoved off for Japan, the mill owner had me over to his club for dinner with his brass. He said I saved him a lot of money, and also had taught him one important lesson.

"'What's that?' I asked.

"'Before straight-jacketing my mind into conventional methods for solving unusual problems,' he answered, 'I'll try to use your simple balloon technique and do some exploring up there in the wide blue yonder.'"—STEVE ELONKA

### Marmy's Mailbox

DEAD CHINESE

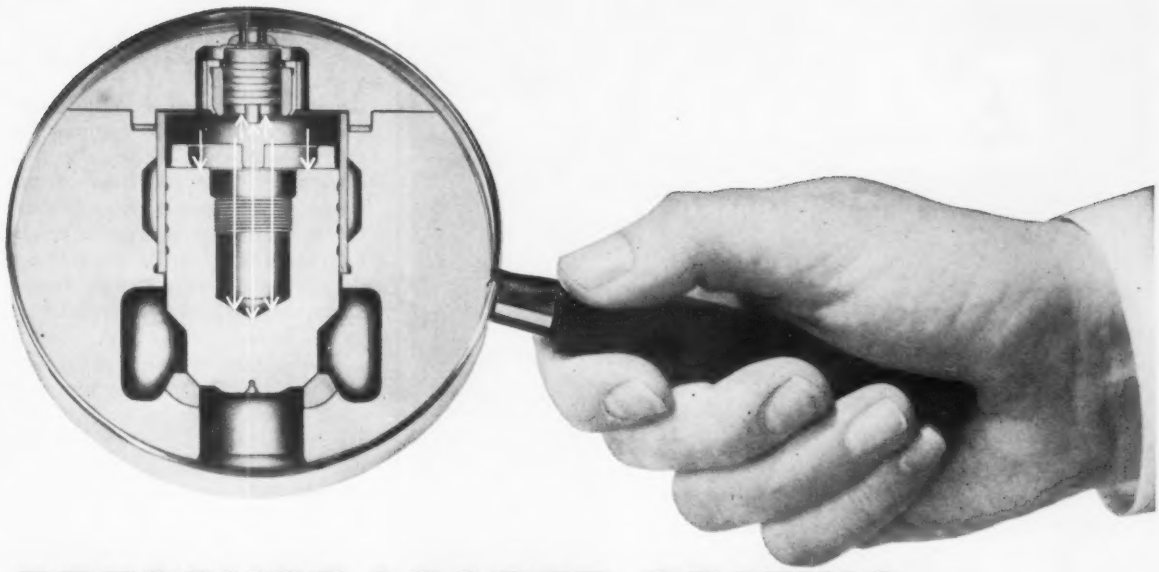
Shame on the old consultant, "Marmy's frozen asset," Jan 58. Suppose someone else hauls a corpse into the Raffles Hotel. Do you think the Chinese waiter will stand another shock like that? Sounds like the kind of trick I always get accused of. It's a shame, that's wot. . . .

G ROSEKILLY, *San Mateo, Calif.*

LIKES BONERS TOO

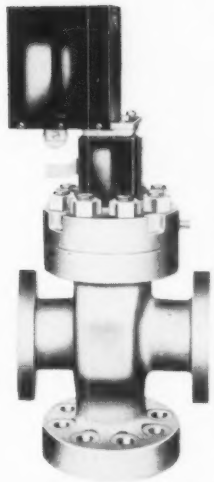
Marmaduke and "Biggest boners" provide an interesting diversion from the more serious aspects of POWER articles. I enjoy both features.

W E BRUMBY, *Levittown, Pa.*



# PRESSURE LOADED SEATING

## minimizes leakage and maintenance



Consolidated Electromatic Relief Valve. Sizes: 2½" to 14". Pressures to 3000 psi. Temperatures to 1120°F. Double Outlet.

Consolidated Electromatic® Relief Valves save steam, pure water, fuel, and "wear and tear" on your spring-loaded valves. Pressure loaded seating permits closer adjustment between operating pressure and set point than in spring-loaded valves. Many Electromatics are used to purge superheaters for faster startups and as superheater vent valves. They greatly reduce chances of superheater damage when firing up a cold steam generator or banked boiler.

Pressure loaded seating is created by channeling steam from the pressure vessel around the Electromatic's exhaust and into its main and pilot valve chambers. Steam pressure in both chambers always matches that in the vessel when the Electromatic is closed.

When pressure exceeds the Electromatic's set point, a signal from controller to panelboard control station results in solenoid thrust that opens the pilot valve, venting the steam faster than it can enter the pilot valve chamber through the clearance between the main valve disc and guide. With pressure in the chambers unbalanced, the main valve opens; steam exhausts until boiler pressure is reduced to the pre-determined setting of the controller. The pilot valve and the main valve close instantly at this point. Action is so fast, the closely adjusted Consolidated Electromatic normally relieves overpressure before the spring-loaded valve's set point is reached. For automatic or manual operation or to cut the valve out of service, a switch is provided on the control station. Send for Bulletin 720.

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***A product of***

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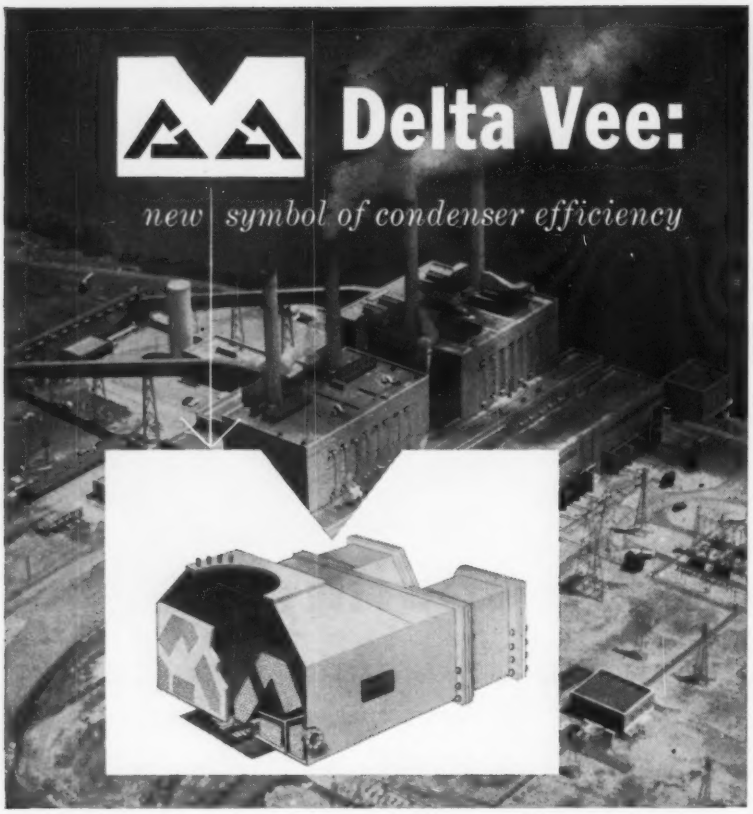



**ONLY SWECO SURFACE CONDENSERS OFFER DELTA VEE DESIGN**

The water circuit uses V-type water boxes and reversing chamber. Roughly 60% of the water feeds the main banks of tubes; the remainder feeds the secondary condensing sections and air-cooling sections at the sides of the water box.

The condensing circuit is in two delta-shaped tube bundles, one group in each half of the condenser. The two groups are mirror images. The main condensing banks are formed by the arms of the deltas; the base forms the secondary condensing sections and the air-cooling sections.

SWECO Surface Condensers are designed for prime mover service with large steam turbines. Available in sizes from 3,500 square feet and up, SWECO Surface Condensers offer these design advantages:

**maximum de-aeration**—from large contact-tube areas, positive steam-vented hot well.

**even distribution of steam**—generous admission area to tube bank reduces water and vapor pressure drop.

**increased efficiency of heat transfer**—condensate forming on upper tubes flows over minimum number of lower tubes, eliminating water blanketing.

**compact installation**—low headroom minimizes excavation or structure necessary to set condenser below turbine.

**accessible for servicing**—end covers are removable, divided water box permits one side of condenser to operate while the other is being cleaned or serviced. (Similar construction is available in non-divided water box design.)

SWECO enters the surface condenser and ejector field with more than forty years experience in the production of pressure vessels and heat exchangers... in thermal and mechanical design... and with complete manufacturing facilities.

Construction, operation and features of SWECO Surface Condensers are described and illustrated in brochure M-3-393. Write for your copy today.

SWECO

**Southwestern Engineering Company**
4800 Santa Fe Avenue, Los Angeles 58, California
*Engineers and Constructors... Manufacturers*

## Draft systems

Continued from page 100

the one f-d fan used in the pressure-fired unit and the two required for the balanced-draft boiler shows a marked reduction in favor of the former. For equal-capacity boilers, the pressure-fired unit's fan hp is only about 60% of that required for the two balanced-draft boiler fans—a considerable saving in auxiliary or captive power.

**Fan tolerance,** or excess capacity required for the specified cfm and static pressure may be reduced with the pressure-fired furnace largely because of the tight setting and lack of uncontrolled air leakage which is inherent in this design. A normal situation might see cfm tolerance reduced from 25 to 20% and static-pressure tolerance reduced from 50 to 30%.

Sealing air leakage into the furnace from around soot blowers and observation doors may be as much as 2 to 3% of total air supplied to some high-capacity high-pressure units. However, overall efficiency including fan power reduction is increased by about .5 to .7%, for a net gain in fuel economy for pressurized units.

Auxiliary and firing equipment, such as soot blowers, observation ports and burner guns, must enter the pressurized furnace through special air-sealed fittings to avoid blow-back and danger to the operator. High-pressure air jets, using f-d fan air which is at about double the furnace pressure, are commonly used for sealing. Various arrangements, such as trap doors, permit burner-gun removal and insertion without any gas leakage.

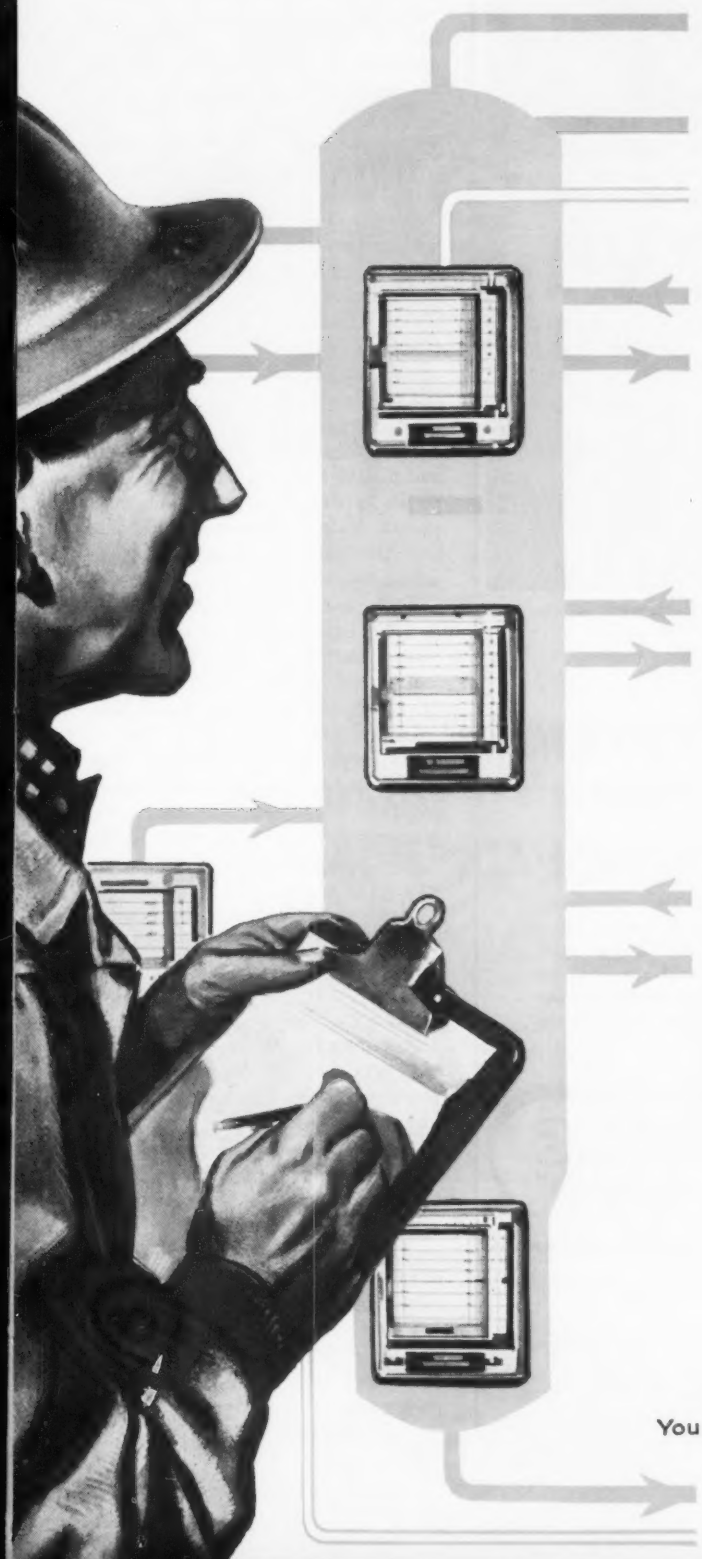
**Combustion control** equipment application to the pressure-fired furnace is relatively simple, because it isn't necessary to maintain a balance between forced and induced draft as in the case of the suction furnace. It's only necessary to force the correct amount of combustion air through the air heater and burner—as judged by outlet gas $CO_2$ or $O_2$—and proportion fuel to suit the load.

---

**Power expansion project** designed to boost capacity of the Utah Copper Div Central Power Station from 100,000 to 175,000 kw has been started by Kennecott Copper Corp.

# Nothing gets by

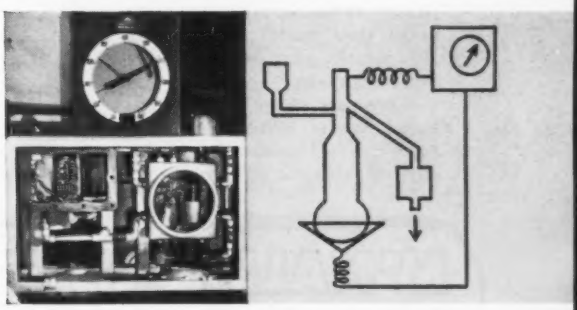
**Automatic end-point testing device developed by Standard Oil research men makes certain of the uniform quality of gasoline and diesel fuel delivered to you.**



Scientists at Standard Oil never stop in their drive to improve and then improve again the uniform quality of the petroleum products that bear the Standard Oil trade-mark. These engineering research scientists have now created wholly new instruments for performing near continuous physical analysis *automatically*.

**One such instrument** automatically performs the physical analysis that determines end-point. Using it, refineries maintain a continuous inspection of the temperature at which diesel fuels are completely distilled. To you, this means that Standard is able to maintain a constant control over the uniformity and high quality of the fuels you use to power your diesel engines. It also means that Standard Oil power-producing petroleum products, with their constantly controlled end-point, burn uniformly, give you uniform high performance.

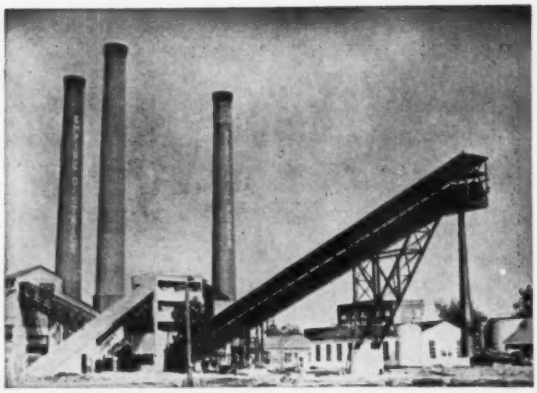
This is part of the research pay-out, the "something more" research builds into the products you buy from Standard. This is your return from Standard's investment in research. And now there are 48 district offices in the 15 Midwest and Rocky Mountain states to serve you. Call the one nearest you. **Standard Oil Company (Indiana), 910 South Michigan Avenue, Chicago 80, Illinois.**



Automatic end-point tester works this way. A small sample is placed in an electrically heated flask. The temperature is measured and recorded during a heating cycle when distillation is accomplished. Distillate is condensed and drained, the flask temperature is lowered by introduction of the next sample, and the apparatus is ready for another test.

You expect more from STANDARD and get it!

**EARN EXTRA PROFITS IN SAVINGS**



McNally Pittsburg developed this 250 ton per hour system for the EMPIRE DISTRICT POWER & LIGHT CO.

McNally Pittsburg assisted in developing this 300 ton per hour system for the KANSAS POWER & LIGHT CO.

**—With Cost-Cutting**

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***Engineered for Your Plant***

**Are you paying "extra fare" luxury rates for that last ride your coal must take from the truck, car, or barge, to your bunkers?**

**Why pay more? Why risk breakdowns, when you can *save* extra "profits" and be sure of year-round efficiency.**

**McNALLY PITTSBURG Systems automatically handle more coal per dollar—minimum maintenance costs.**

**The men who know coal from the ground up will be glad to study your coal-handling problems with you. Mail coupon.**

**McNALLY PITTSBURG**

*"The Men Who Know Coal From The Ground-Up"*

**McNally Pittsburg Mfg. Corp., Dept. PO, Pittsburg, Kansas**
**Gentlemen: Send more information on your Coal-Handling Systems.**

**Name**_____ **Title**_____

**Company**_____

**City and State**_____


## My biggest boner

My biggest boner made a one-armed man out of me—as far as switchboard operation is concerned. I had been a central-station switchboard operator for several years and had synchronized generators and power lines so many times I could go through the motions while half asleep.

Our switchboard was several stories above the turbine room and on the opposite side of the building. Communication was by telephone. For turbine-generator start-up or shutdown a panelboard system was used. Identical panelboards in switchboard and turbine rooms had small lettered translucent panels, each having two pushbuttons alongside each panel. When turbine-room engineer pushed a button on his board a bell rang and a light came on behind identical panels in the turbine and switchboard rooms. Switchboard operator would push the "off" button on his panel to acknowledge the signal.

Early one morning the bell rang and the light flashed on behind the turbine-start panel. I acknowledged and waited for the "Field On" and "Up to Speed" bells which followed.

Later, while regulating turbine speed preparatory to synchronizing, I had one hand grasping the turbine-governor knob and the other hand grasping the main OCB switch knob.

Yup, you guessed it. I pulled the wrong knob.

Strange as it seems the switch closed at precisely the right split second. I was so shook up that I didn't even pick up load, but just flopped back in my chair.

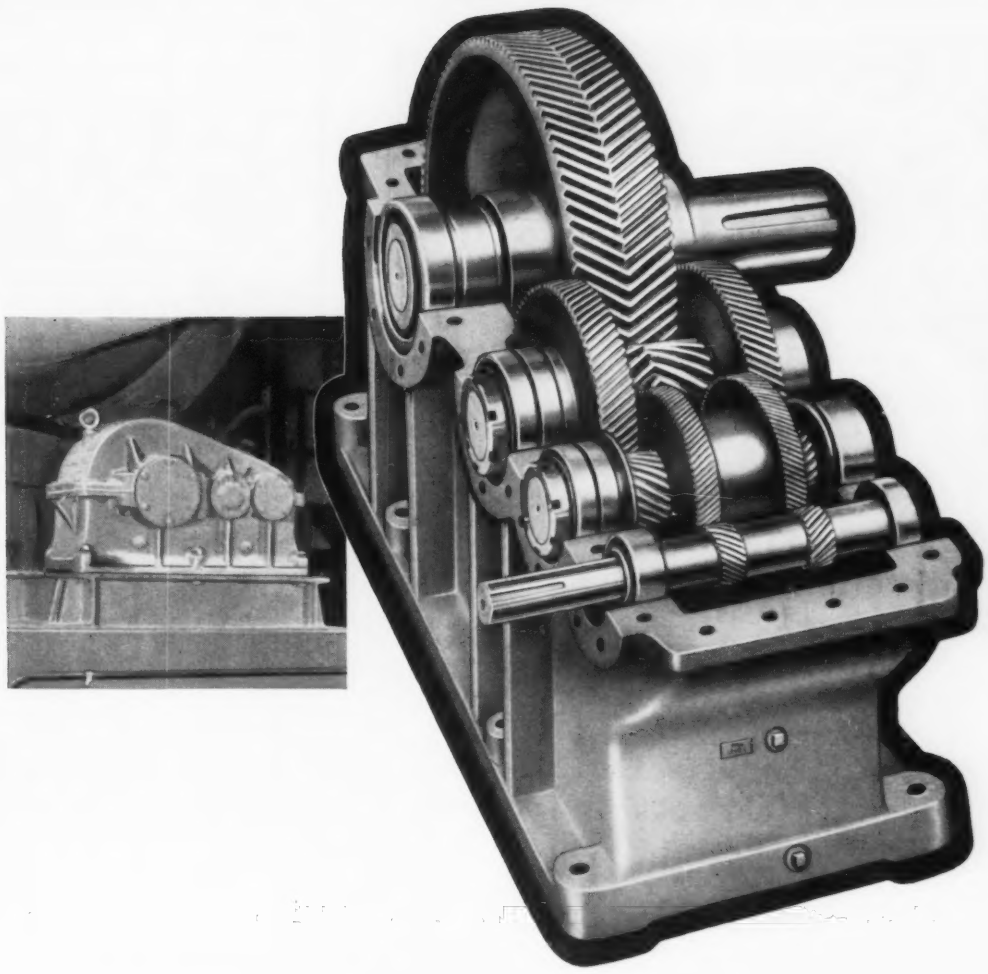
A minute or so later the phone rang and the engineer asked, "Hey, you going to get this machine on the line sometime today?"

"She's on Mister," I replied.

"Well that's darned funny, cause I sure don't hear it," he answered.

Since then I have broken in many switchboard operators and every one of them was taught that as far as switchboard operation went, they were to completely forget they had two hands. If that was too complicated, they were to keep one hand in their pocket.

L S Frahs, *San Francisco, Calif.*



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Housings are specially reinforced at points of greatest stress. Extra heavy bearings take shocks and heavy overhung loads in stride. Result: shaft alignment is accurate . . . and it stays accurate. Gears, pinions and bearings last longer.

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Preventive maintenance in power plants is simplified when you make Magnaflux Field Inspection Service a regular part of your scheduled maintenance plan. Magnaflux field engineers, thoroughly experienced, use numerous exacting tests to spot future trouble quickly and reliably, saving your own people many hours of inspection time.

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Magnaflux Commercial Inspection Plants in 16 cities make an experienced "pool" of trained field engineers available to you on a 24-hour basis. When you need this service, your Magnaflux team is as close as your telephone. This nationwide service gives you all the benefits of a specialized, fully trained crew on a stand-by basis—*but on your payroll only while they are working for you.* When you schedule your next overhaul, also schedule the Magnaflux Inspection Service to give any degree of inspection you may require. Also, we have a folder on "Power Plant Maintenance". Write, if you'd like a copy.

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HALLMARK OF QUALITY IN TEST SYSTEMS


## Lubrication

Continued from page 112

Study your lubrication selection carefully if the compressor is handling wet vapors or dirty or corrosive gases. Normally, a high-grade straight-run mineral oil with minimum flash point of 375 F and minimum viscosity of 55 ssu at 210 F should suffice.

Provide scrubbers, traps, or tanks to clean and dry gases entering the cylinder. Moisture and other contaminants weaken oil film, increasing danger of excess wear. Eliminate one source of water by draining off condensate in suction piping through use of receivers. If you can't avoid compressing wet vapors, place heat exchangers in the inlet line to help dry the gases.

**Dirt** brought into cylinder area by air or gas can put a crimp in piston and cylinder liner life. This is especially true if moisture is present along with the dirt. Commercial filters attached to the intake line will usually minimize a dirt or dust problem, but only if they are properly maintained.

## Diesel engines

Continued from page 97

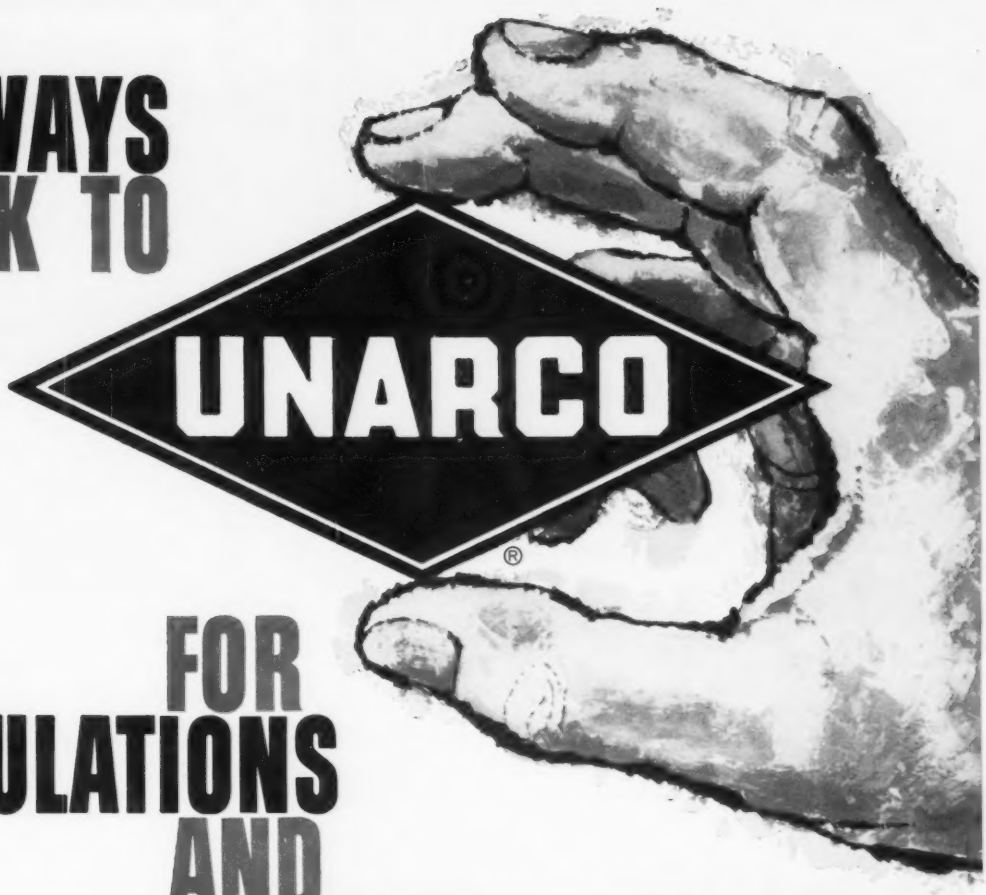
When ignition temperature of the fuel is too high, quite a bit of fuel enters during Fig. 6*g* to *i* before the first part to enter ignites. Once it does and starts burning, the temperature of the later fuel already in the cylinder rises rapidly. This fuel then ignites and burns at an explosive rate causing detonation or knocking. Pressure can't be held constant with this kind of burning, so we get a knock.

So we see that late ignition of the first part of the fuel to enter the cylinder causes diesel detonation. The fuel must have a relatively low ignition temperature to avoid knocking.

This characteristic is measured by an arbitrary scale of "cetane rating." Higher cetane-number diesel or distillate oils are less likely to detonate. Lower compression diesel engines generally run satisfactorily on lower cetane-number oils.

*Next part will deal with practical engine cycles—in an upcoming issue.*

# ALWAYS LOOK TO UNARCO® FOR INSULATIONS AND ASBESTOS PRODUCTS



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RIDGID
number for
drop-head pipe dies
unequaled for easy
work, good threads and
extra long service!
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No wonder pipe "pros" have bought hundreds of thousands of them, the easy way they snap into the ratchet ring handle . . . the smooth clean way they cut ⅛" to 1" threads . . . the quick way the dies reverse for close-to-wall threads. You'll like OOR's, too—get 'em at your Supply House.

The Ridge Tool Company, Elyria, Ohio, U.S.A.


## Expansion joints

Continued from page 115

sures. Curve is plotted to include a 10% margin of safety over actual pipe expansion (from ASA *Code for Pressure Piping, 1951*) to compensate for installation discrepancies or possible unforeseen temperature extremes.

Suppose, for example, you wanted to select a slip joint for a 210-ft addition to your steel piping system carrying 200 psi saturated steam. Enter the top scale at 200 psi, read down to expansion curve, then left to expansion scale. Expansion in 210 ft equals 210/100 × 3.50 = 7.35 in. So, select a joint with an 8-in. traverse.

Now, suppose you wanted to operate the same system at 125-F superheat. Read down from 200 psi on the top scale to saturation temperature (388 F) on bottom scale. Add 125-F superheat. Total temperature is now 513 F. From this (bottom scale) read up to expansion curve, then left to expansion scale which gives, in this case, 4.80 in. per 100 ft. Expansion in 210 ft equals 210/100 × 4.80 = 10.08 in. So, select a joint with a 12-in. traverse.

Where lowest possible ambient temperature is *below* 0 F, determine (from curve) amount of expansion for temperature range below 0 F and *add* this to expansion for temperature above 0 F. Where lowest possible ambient temperature is *above* 0 F, determine expansion for range between 0 F and lowest ambient temperature and *subtract* this from expansion for temperature above 0 F.

ASA *Code for Pressure Piping* stipulates that joint anchors must be designed to withstand the sum of three thrusts: (1) Internal pressure thrust which equals line pressure times pipe (or sleeve) area. (2) Packing friction thrust—resistance to sleeve motion in stuffing box—calculated at 300 lb (maximum) per in. of pipe size. (3) Pipe-support friction thrust—friction in pipe hangers, supports and alignment guides—which may be calculated at 100 lb per 100 ft of pipe per in. of nominal pipe size (a reasonable estimate) if thrust isn't accurately known.

**Intermediate anchors,** located between end anchors, are subject to thrusts (2) and (3) above. Thus, end anchor loads depend on line pressure,

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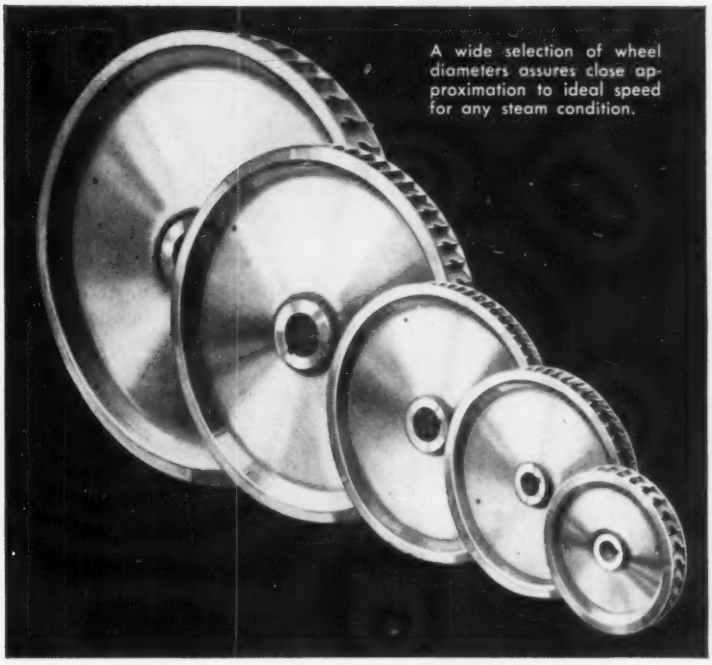
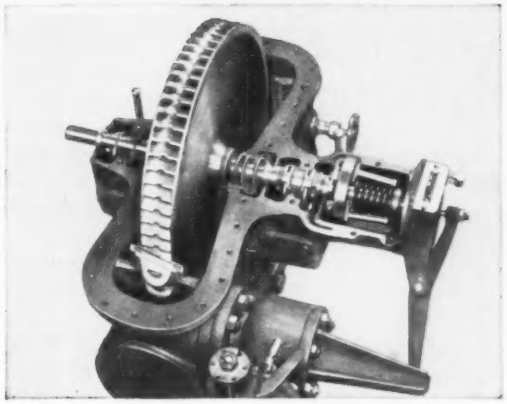
# SOLID-WHEEL DURABILITY COMES IN ALL SIZES...



A wide selection of wheel diameters assures close approximation to ideal speed for any steam condition.



Terry wheel turbine with cover removed to show the solid wheel. There are no separate parts to loosen or work out. Blade clearances are generous.

## up to 2000 HP

Wherever you need dependable turbine drive up to 2000 HP—and strength and durability are major factors—Terry solid-wheel turbines are specifically equipped for the job. For, within their simple, sturdy casing is a rugged one-piece wheel.

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- Solid one-piece wheel.
- Large radial and axial clearances.
- Double rim protected blading.
- Individual nozzle control.
- Dependable and durable governor.
- Heavy dust-proof bearing and governor housing.
- Independent overspeed trip with separate valve.
- Sturdy casing design.
- Strong and easily inspected steam strainer.
- Truly accessible construction, which makes inspection of the interior parts a simple matter.

*For full details, send for a copy of bulletin S-116.*

**THE TERRY STEAM TURBINE CO.**
TERRY SQUARE, HARTFORD 1, CONN.

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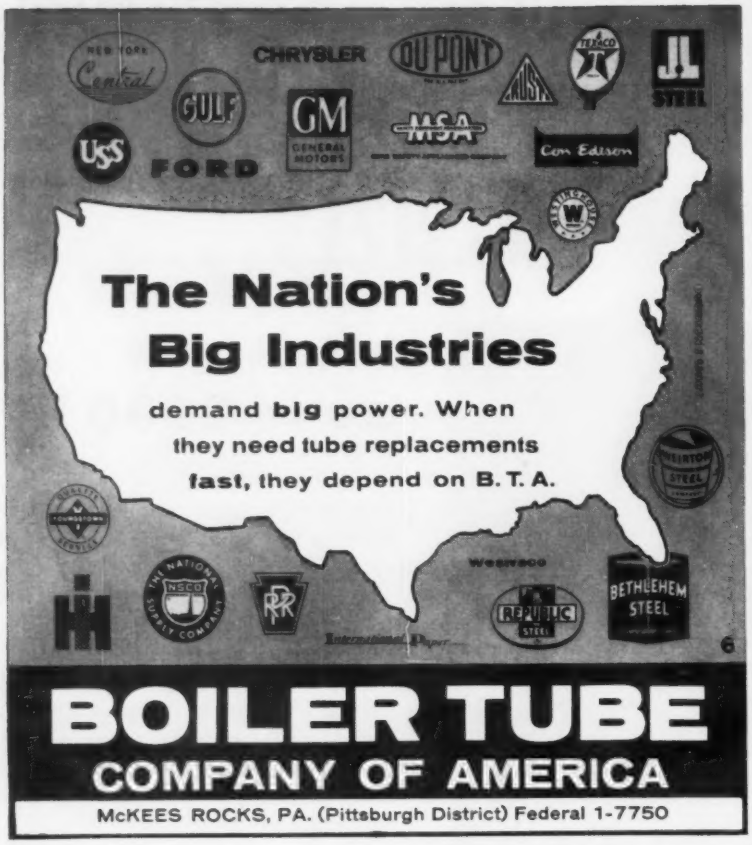

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The Viking Pump line exceeds all others in the rotary pump field. This one fact alone means you can have a pump to really fit your needs . . . one that is efficient for your job.
Send today for the new 36-page catalog giving complete data on 274 General Purpose Viking Pump models. Capacities from ⅔ to 1050 gallons per minute.
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Positive Displacement Principle
and how it works
Showing the way

## Expansion joints

Continued from page 160

while intermediate anchor loads are independent of line pressure. Chart, p 115, can be used to determine these loads. Assume a 12-in. pipe operating at 250 psi steam pressure. End anchor load proves to be 41,000 lb and intermediate anchor load is 12,000 lb.

## Chemical pumps

Continued from page 91

ical pumps were not properly designed. They certainly weren't built for 3500-rpm operation. But there should be no qualms about using this speed with today's improved designs. Just make sure that the shaft is sufficiently rigid (deflection at 3500 rpm is four times that at 1750 rpm) and choose a pump that's heavy enough.

**Varying impeller diameter** is another way to alter pumping performance at any one speed. Capacity varies directly with impeller diameter and head as the ratio of squares of the diameter. As a general rule, almost any diameter impeller can be selected. But, if maximum diameter isn't used, full value of the pump isn't obtained. However, this is often a good way to reduce the size of motor needed.

Bhp varies as ratio of the cube of impeller diameters. For example, trimming the impeller from 10 to 9½-in. reduces the head from 100 to 90 ft and lowers required horsepower by 14.2%. A trimmed impeller pump also has some built-in flexibility. In the event of a plant expansion or other need for increased capacity, the impeller can be changed to produce some additional head.

**Motor sizing** follows selection of a specific pump, speed and impeller. The performance curve indicates bhp at specified capacity. Note that bhp increases as system head is reduced and capacity increases. If this happens, the pump will move out along its curve, bringing up possibility of overloading the motor. This is particularly true when it's sized exactly for rated capacity. It's even more so when specific gravity of the liquid is greater than unity.

There is often one saving grace:

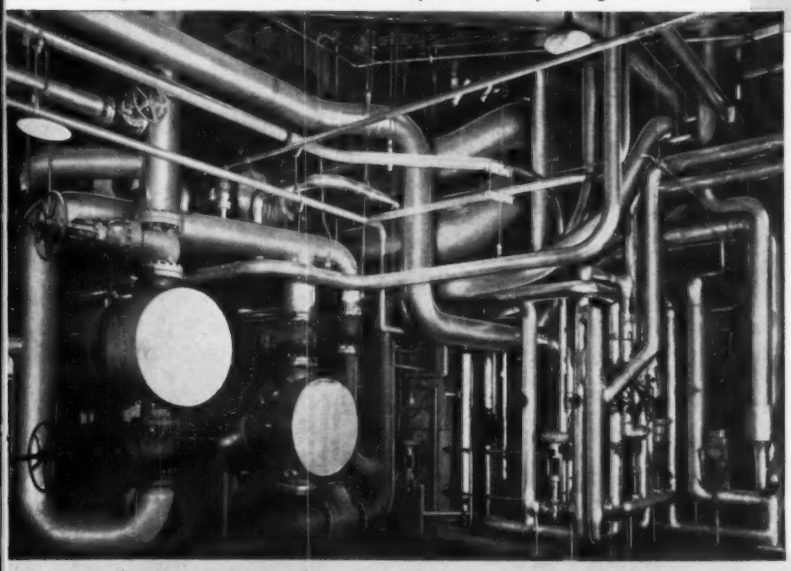
# He's Looking For MONEY

Midwest Piping at Kyger Creek plant which has a capacity of 1,075,000 kw and is the largest power plant piping contract (combining fabrication and erection) ever performed by a single contractor.

This Midwest Piping Engineer is going over the customer's piping drawings in the light of his long experience in shop fabrication and field erection. He's looking for ways of doing a piping construction job better and at less cost.

Before a construction job is placed in the Midwest shops for fabrication, experienced engineers prepare Field Erection Sketches dividing each line into a series of subassemblies. These Sketches minimize and simplify the field welding . . . the difficult work is done in our well-equipped shops. They also disclose any discrepancies before fabrication instead of during erection. All erection planning has been done by our engineering staff . . . which reduces field thinking and eliminates guesswork. Erection is from these sketches instead of from the design engineers drawings . . . this speeds up the work and results in a real cost saving and earlier completion of the job.

The next time you have a piping job, you'll find it profitable to call in Midwest.



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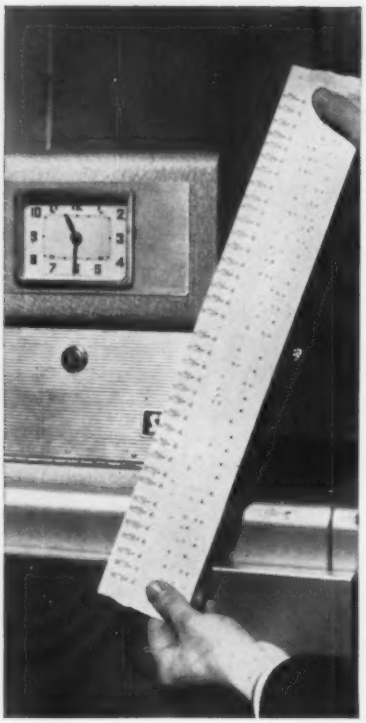

## Recording Annunciator monitors equipment, cuts operating costs

Pinpointing trouble is the job of the new Panalarm Recording Annunciator. It prints on tape exactly when off-normal and return-to-normal conditions occurred in an operating system. Advancing tape only after each printing, it gives a compact, exact, permanent record of operations.

Simultaneously checking as many as 32 points in an operating system, it records to the second exactly when a piece of equipment goes off-normal. For more complex operations, there is now available a Panalarm Recording Annunciator capable of monitoring up to 100 points in a system.

By monitoring your equipment and giving an exact record of its operation, the Panalarm Recording Annunciator helps lower maintenance costs and reduce downtime in your plant.

*Write for Recording Annunciator Bulletin 102*

PANALARM®

Division of **PANELLIT, INC.**

7409 N. Hamlin Ave., Skokie, Illinois


## Chemical pumps

*Continued from page 162*

Friction increases considerably at the higher flow rate. Added head that the pump must handle acts as a brake to prevent motor overloading. Conservative approach is to size the motor for end-of-curve or nonoverloading conditions. This can be costly when large motors are involved.

**Extremely low flows** or operation close to shutoff call for special care in centrifugal-pump selection. Low flow for a standard chemical pump with shaft of average size means running at 10% or less of maximum capacity. Operating at this close to shutoff position means that (1) stuffing-box pressure increases, making it difficult to seal the shaft and (2) shaft deflection greatly increases, also causing a difficult packing or mechanical-seal problem.

One way out is to have the pump handle more solution than necessary. Difference between the quantity pumped and that actually used is recirculated back to source of supply. Another solution: Use a pump with a heavy shaft. If the shaft is rigid enough, deflection isn't a problem. Combination of a true running shaft and a properly maintained stuffing box will give a good shaft seal in spite of high stuffing-box pressures. There is the problem of temperature rise when a 3500-rpm pump is operated at 1 or 2 gpm. But, if the liquid is transferred and not continually recirculated, chances are temperature build-up will not be damaging.

**NPSH** is the minimum absolute pressure at suction nozzle of the pump to prevent vapor flashing of liquid in the pump. Flashing causes loss of prime or operation in a partially starved condition. The results can be disastrous, although it's rarely a problem if there is atmospheric pressure on the liquid surface in the pump supply tank. NPSH should be calculated if liquid has a relatively high vapor pressure or is close to the boiling point.

**Viscosity** is final characteristic of the solution that must be investigated. If the solution is viscous (over about 25 centipoises), it must be considered in pump selection. Head and capacity developed by the pump will be less than when pumping water with a viscosity of one centipoise. Horsepower consumed by the pump in-

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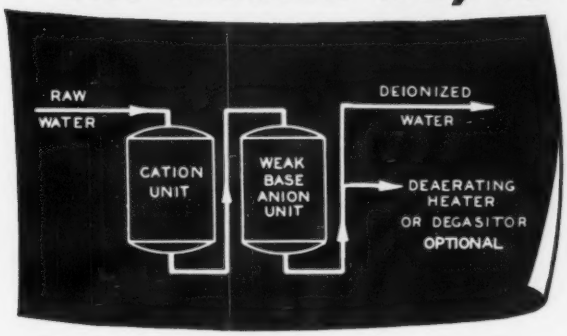
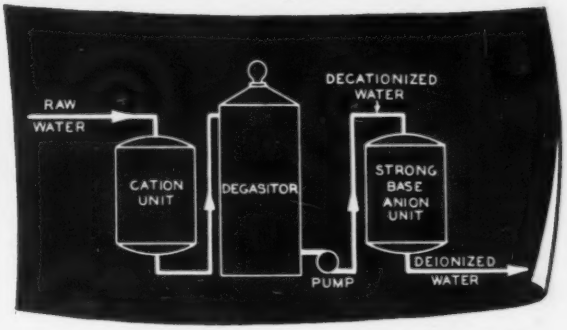
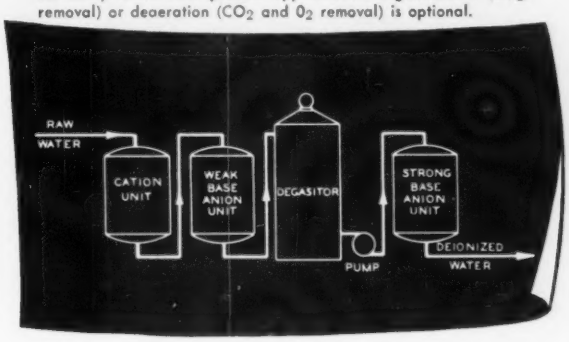


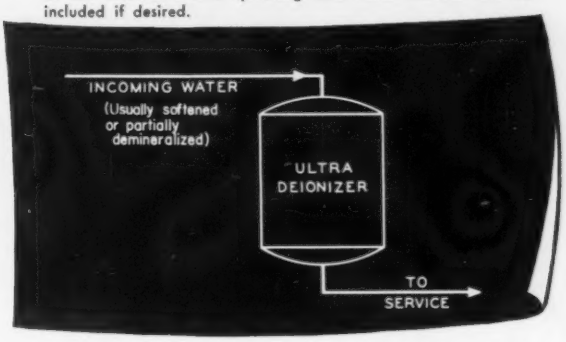

Delivers deionized water quite low in dissolved solids and suitable for many boiler and process applications. Degasification ($CO_2$ removal) or deaeration ($CO_2$ and $O_2$ removal) is optional.




Delivers high quality mineral-free water and eliminates $CO_2$ at low investment and operating cost. Silica removal can be included if desired.




Used where water high in quality and free of $CO_2$ and silica is desired. A most economical system for high-bicarbonate waters.




Mixed-bed unit produces deionized water of highest known chemical purity. Removes $CO_2$ and silica. Used alone and as a "polishing" unit.

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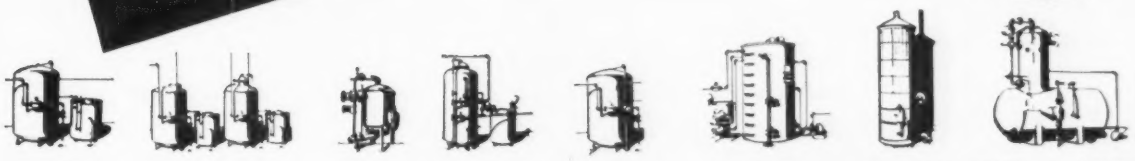
WATER CONDITIONING



SOFTENERS ION EXCHANGERS FILTERS DEIONIZERS DEALKALIZERS CLARIFIERS DEGASITORS DEAERATING HEATERS

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## Chemical pumps

Continued from page 164

creases materially with more viscous solutions. If the solution seems at all viscous, determine its viscosity. Then calculate its effect by means of the method outlined in the *Standards of the Hydraulic Institute.*

In practice, if the solution is not so viscous that it won't flow to the pump, it can be handled by a centrifugal design. But allowance must be made for reduced performance and increased horsepower requirements.

## Free literature

Begins on page 145

**11** **Diesel engines,** 88- and 131-hp units, are described in 16-p catalog BU-413. Photos, cutaways, charts included. Allis-Chalmers Mfg Co, Milwaukee 1, Wis.

### PIPING, VALVES, FITTINGS

**12** **Float valves,** single-seat design for 15 to 150 psi, are described in 2-p catalog sheet. Atlas Valve Co, 280 South St, Newark 5, N. J.

**13** **Nozzle safety-relief** valves are listed in 44-p catalog FE-118. Gives sizing factors and formulas, capacity charts, dimension and weight tables. Farris Engineering Corp, 627 Commercial Ave, Palisades Pk, N. J.

**14** **Forged-steel globe** valves are covered in 4-p bulletin DH-213. Lists material and dimension specs, pressure - temperature ratings. American Chain & Cable Co, Inc, 99 Connecticut Ave, Bridgeport 2, Conn.

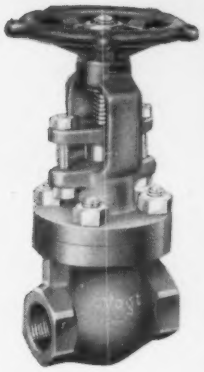
**15** **Solenoid valves** are covered in 8-p stock list. Contains ratings, flow diagrams, illustrations, engineering data for 2-, 3- and 4-way valves. Automatic Switch Co, Hanover Rd, Florham Pk, N. J.

**16** **Multiport relief valves** for steam systems are discussed in 8-p bulletin 5200-A. Specs are given for vertical, horizontal and angle styles in 4- to 48-in. sizes, 0-100 psig pressures. Cochrane Corp, 17th St & Allegheny Ave, Philadelphia 32, Pa.

### METERS AND INSTRUMENTS

**17** **Annunciator** using static-magnetic controls with no moving parts is described in 4-p folder 101. Includes logic diagram. Panellit, Inc, 7401 N Hamlin Ave, Skokie, Ill.

**18** **Pneumatic transmission** line is described in 4-p product spec sheet



150-800 POUNDS SERVICE
2000 POUNDS COLD, W.O.G.
SIZES ¼" THRU 2"

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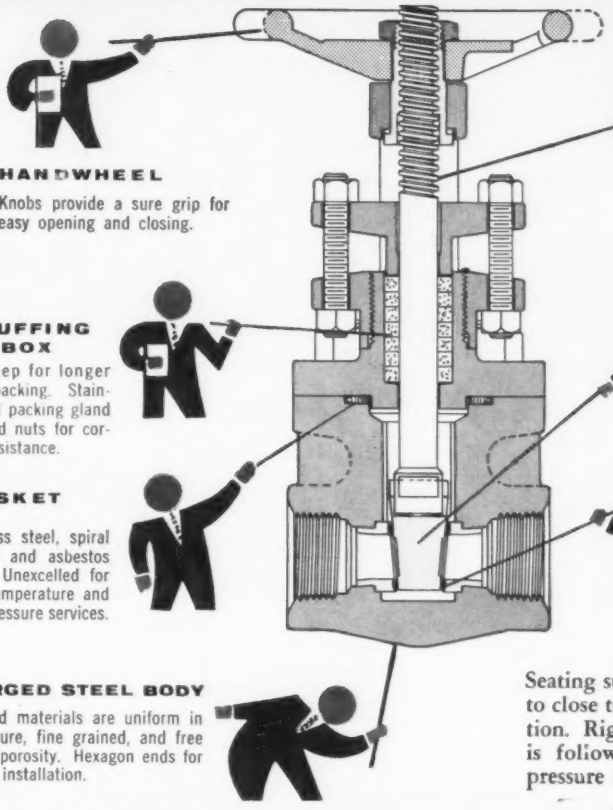
ROUND BOLTED BONNET, BOLTED GLAND

FORGED STEEL GATE VALVE

## with 7 superior features



**1 HANDWHEEL**

Knobs provide a sure grip for easy opening and closing.

**2 STUFFING BOX**

Extra deep for longer life of packing. Stainless steel packing gland studs and nuts for corrosion resistance.

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Stainless steel, spiral wound, and asbestos filled. Unexcelled for high temperature and high pressure services.

**4 FORGED STEEL BODY**

Forged materials are uniform in structure, fine grained, and free from porosity. Hexagon ends for easy installation.

**5 STEM**

13% Chrome stainless steel. A special high melting point alloy yoke nut assures prolonged wear resistance.

**6 WEDGE**

13% Chrome stainless steel of approximately 500 Brinell for longer wear.

**7 SEATS**

13% Chrome stainless steel, hard faced with *HAYNES STELLITE or equivalent for stubborn resistance to seat wear.

Seating surfaces are precision machined to close tolerances for drop tight operation. Rigid inspection of finished parts is followed, after assembly, by final pressure tests of body and seats.

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Vogt GENERAL GP PURPOSE Vogt FOR BETTER VALVES

HENRY VOGT MACHINE COMPANY, Louisville, Ky.

SALES OFFICES: New York, Chicago, Cleveland, Dallas, Camden, N. J., St. Louis, Charleston, W. Va., Cincinnati.

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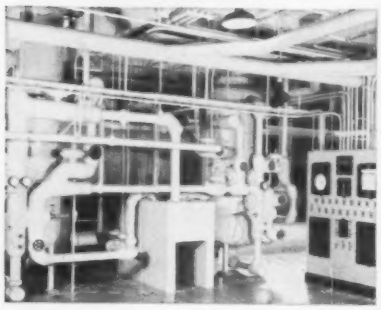
VALVES

ILLCO-WAY
ionXchange

De-ionized Water FOR



POWER PLANTS

One of the greatest advancements in recent years has been the successful development of the de-ionization process for the purification of boiler feed water in power plants. This development has been particularly important with modern high-pressure boilers where virtually-complete removal of silica is vital. Illinois Water Treatment Company has pioneered in the practical design and reliable manufacture of such water-treating equipment.

SAVES MONEY IN LOWERED COSTS

Power plants which have installed this equipment have done so on an investment basis, and are today enjoying good returns in the form of greater operating efficiency, much less maintenance, and substantially lower steam costs. Compared with other methods of treatment for boiler feed water, ILLCO-WAY ion-Xchange will usually be found to offer the lowest overall expense coupled with the best performance. *For details, call your ILLCO-WAY representative, or write . . .*

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Rockford, Ill.

NEW YORK OFFICE: 141 E. 44th St., New York 17, N.Y.
CANADIAN DIST.: Pumps & Softeners, Ltd., London, Ont.

## Free literature

Begins on page 145

G91-9. Tables give sizes, weights, tubing and protecting materials, installation info. Bailey Meter Co, 1050 Ivanhoe Rd, Cleveland 10, Ohio.

19 **Pneumatic valve-position** transmitter is subject of 2-p bulletin 285-R1. Illustrated with photos, drawings. B-I-F Industries, Inc, 345 Harris Ave, Providence 1, R. I.

20 **Bellows flowmeter** is discussed in 4-p bulletin S292-2. Includes features, specs. Minneapolis-Honeywell Regulator Co, Industrial Div, Wayne & Windrim Aves, Philadelphia 44, Pa.

21 **Receiver-recorder** and controller for pneumatic and electric transmission and mechanical measuring systems is subject of 16-p spec booklet. Lists plug-in components, has photos, diagrams. Bailey Meter Co, 1050 Ivanhoe Rd, Cleveland 10, Ohio.

### MECHANICAL TRANSMISSION

22 **Fractional-hp** "dry-fluid" drives and couplings are discussed in bulletins A665 and A681. Units are designed for ¼- to ¾-hp motors at 1750 rpm. Dodge Mfg Corp, Mishawaka, Ind.

★ **Variable-speed** motor pulley is covered in 20-p bulletin V-582. Includes specs, diagrams. ★Request direct on company letterhead. Reliance Electric & Engineering Co, Reeves Pulley Div, 1225 Seventh St, Columbus, Ind.

### MATERIALS HANDLING

★ **Conveyor systems** are discussed in 90-p catalog 6. ★Request direct on company letterhead. Conveyor Systems, Inc, Morton Grove, Ill.

23 **Wire-rope** use and care is given in 36-p handbook. Includes selection, methods of socketing, splicing and installation. Wire Rope Corp of America, St Joseph, Mo.

24 **Ceramic magnet pulleys** are topic of 4-p bulletin 1021. Includes selection chart, diagrams. Stearns Magnetic Products, 635 S 28th St, Milwaukee 46, Wis.

### HEAT EXCHANGERS

25 **Induced-draft** packaged water cooling towers are discussed in 4-p circular SP-1. Charts give specs, dimensions and performance ratings. Mason Products, Inc, Section 3, 317 Main St, West Concord, Mass.

26 **Compact** heat exchanger is described in 12-p bulletin. Flow diagrams are given for five applications, others are suggested. Includes cutaway drawings and schematic diagrams. Air Preheater Corp, 60 E 42nd St, New York 17, N. Y.

(Continued on page 170)

Here's the Great Combination for those...

Medium Pressure Boilers
*(up to 150 lbs. psi.)*

The No. 150 controls the boiler feed pump the one right way—directly from the boiler water level. Holds boiler level within close limits to assure maximum steaming efficiency and fuel economy. Has extra switch which provides circuits for cutting off burner and sounding alarm in case of low water emergency. It's the most widely-used, time-proved control of its kind.

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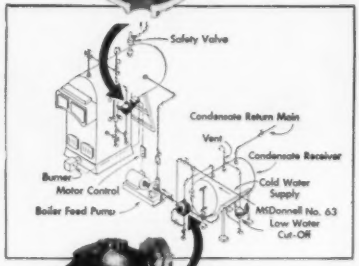
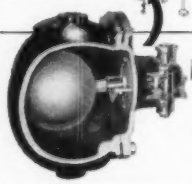
McDONNELL
No. 150
PUMP CONTROL



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No. 27T
MAKE-UP
FEEDER

Adds water to condensate receiving tank whenever necessary to make up for any deficiency in returns. Large feeding capacity meets any sudden boiler demand for water. Needle and seat are stainless steel assuring powerful drip-tight closure. For tank pressures to 35 psi., supply pressures to 100 lbs.

*Write for simple installation and wiring diagrams*

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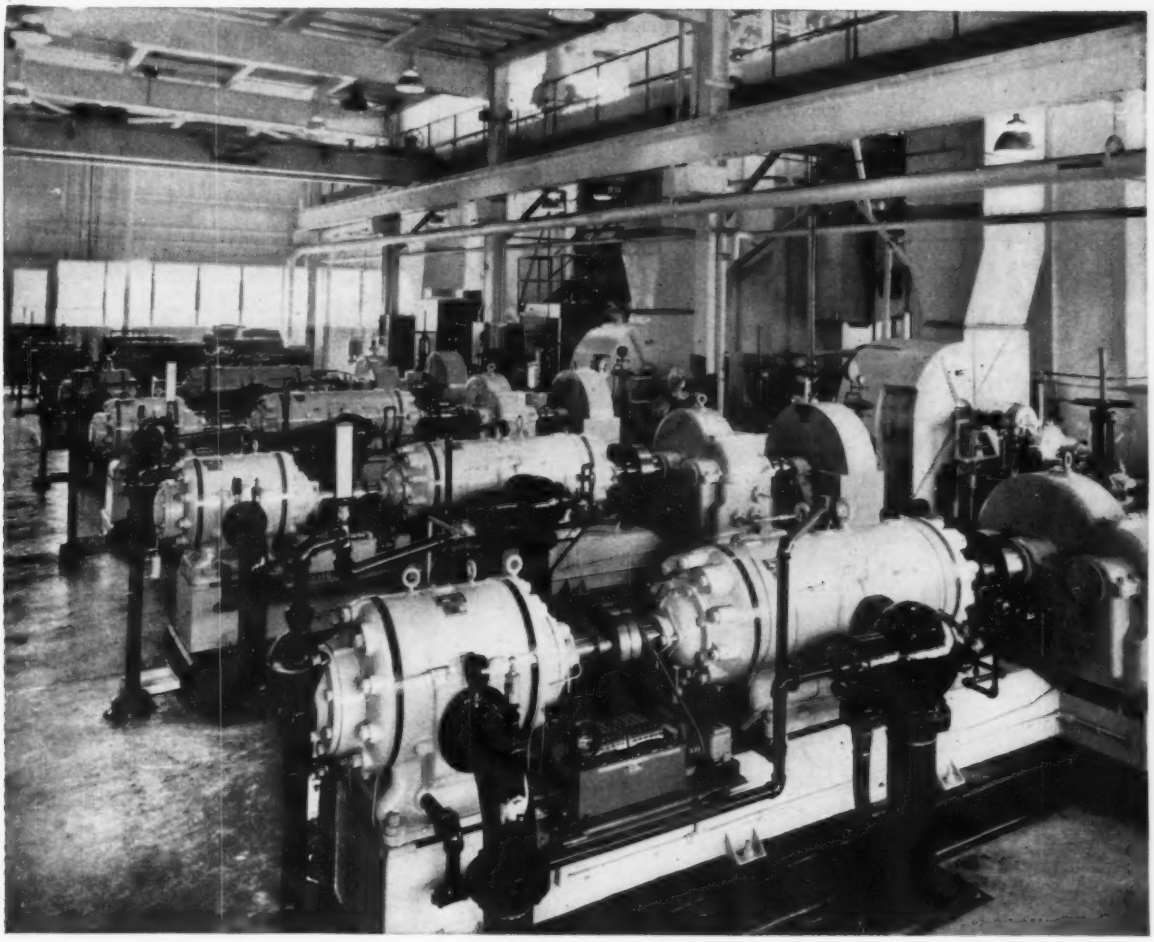
Doing One Thing Well
McDONNELL
Boiler Water Level Control
and Safety Devices



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This is just one of many production records set by Fuller Rotary Compressors—in this case by each of six machines installed in a leading aircraft plant. The only maintenance or replacement necessary over this period was installation of high and low pressure blades. Bearings held up 100%.

Fuller rotary compressors shown are four C-300-300H, steam turbine drive, capacity each 1248 to 1805 c.f.m., with speed ranges of 450 to 650 r.p.m., 125-lb. gauge pressure, and two electric motor drive, capacity each 1663 c.f.m., at 600 r.p.m., 110 lb. gauge pressure.

Your plant, too, can take advantage of the many cost-saving advantages of Fuller rotary compressors; such as smooth airflow, lack of vibration minimum of moving parts, adaptability to any production setup, and the advantage of "one man" operation.

Write today to Fuller Company and get complete data on how Fuller rotary compressors can give you more air power at less cost.

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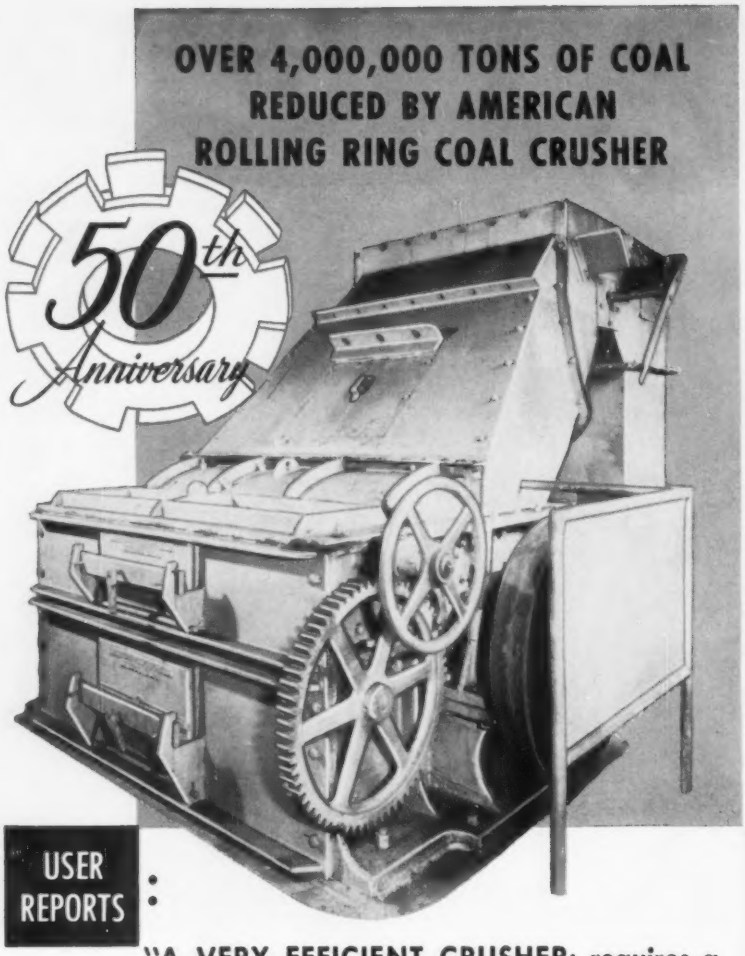


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A Midwest Power Plant engineer made this comment and gave the information below about the operation of their American AC 3-E Rolling Ring Coal Crusher.

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| Total Tonnage Reduced | Over 4,000,000 tons |
| Feed | 20% Nut (3" x 1½")<br>80% Screenings (1½") |
| End Product | Minus ½" |

Performance reports like this are standard on American Crushers. Each crusher is custom-built to suit your requirements. The American performs as an efficient crusher, producing high tonnage at slow operating speeds — saving power and maintenance. The manganese steel shredder rings are reversible for double life, crushing chambers have renewable liners, and housings are sectional for easy accessibility to rotor, and machined for a dust-tight fit. These, and many other features have been developed throughout 50 years of experience.

Our engineers will analyze your reduction problems and make recommendations of the correct size and type of crusher. No obligation, of course. Write for literature, stating your tonnage requirements.

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ORIGINATORS AND MANUFACTURERS OF RING CRUSHERS AND PULVERIZERS
1349 MACKLIND AVE. SAINT LOUIS 10, MISSOURI


## Free literature

Begins on page 145

### ELECTRICAL EQUIPMENT

**27** **Silicone - rubber** insulated cables are subject of 16-p booklet. The book is said to help power-plant engineers prepare specs for special cable installations. Includes photos, charts. National Electric Products Corp, Gateway Center, Pittsburgh, Pa.

**28** **Equipment,** including load centers, circuit breakers, starters, panelboards and switchboards, is listed in 160-p catalog 141. Application data is also given. Square D Co, 6060 Rivard St, Detroit 11, Mich.

**29** **Battery racks** are covered in 12-p illustrated catalog 70.00. Includes specs. The Electric Storage Battery Co, Exide Industrial Div, Box 8109, Philadelphia 1, Pa.

**30** **Automatic transfer** switches are listed in 24-p bulletin. Includes photos, requirements, info on features. Automatic Switch Co, Florham Pk, N. J.

### COMPRESSORS

**31** **Stationary units,** heavy-duty high-pressure type, are detailed in 8-p bulletin A-93. Installation photos, sectional drawings and charts describe four models with capacities from 368 to 2000 cfm. Joy Mfg Co, Oliver Bldg, Pittsburgh 22, Pa.

**32** **Blower compressor** unit with axial-flow and positive-displacement features is subject of 4-p folder CB-157. Includes engineering data, performance curve. U. S. Hoffman Machinery Corp, 105 Fourth Ave, New York 3, N. Y.

### BOILERS AND ACCESSORIES

**33** **Data card** TDC-157 is for welded carbon-steel boiler tubes. It lists maximum allowable working pressures by tube sizes. Info is based on ASME Boiler Construction Code. Babcock & Wilcox Co, Beaver Falls, Pa.

**34** **Torque-control unit,** tube expanders, cutters and accessories are discussed in 32-p bulletin 81. Includes photos, diagrams and specs. Gustav Wiedeke Co, 1833 Richard St, Dayton 1, Ohio.

**35** **Scrubber** is described in 4-p brochure 500. Includes cutaway views of two types. Centrifix Corp, 3608 Payne Ave, Cleveland 14, Ohio.

---

**Safety and relief valves** is the 28th publication in the ASME Power Test Code series. Instructions provide recommended test procedure and instrumentation for testing valves handling steam, gases including air, and liquids. Includes spring-loaded, weight-loaded, pilot-operated units.

# POWELL

## world's largest family of valves

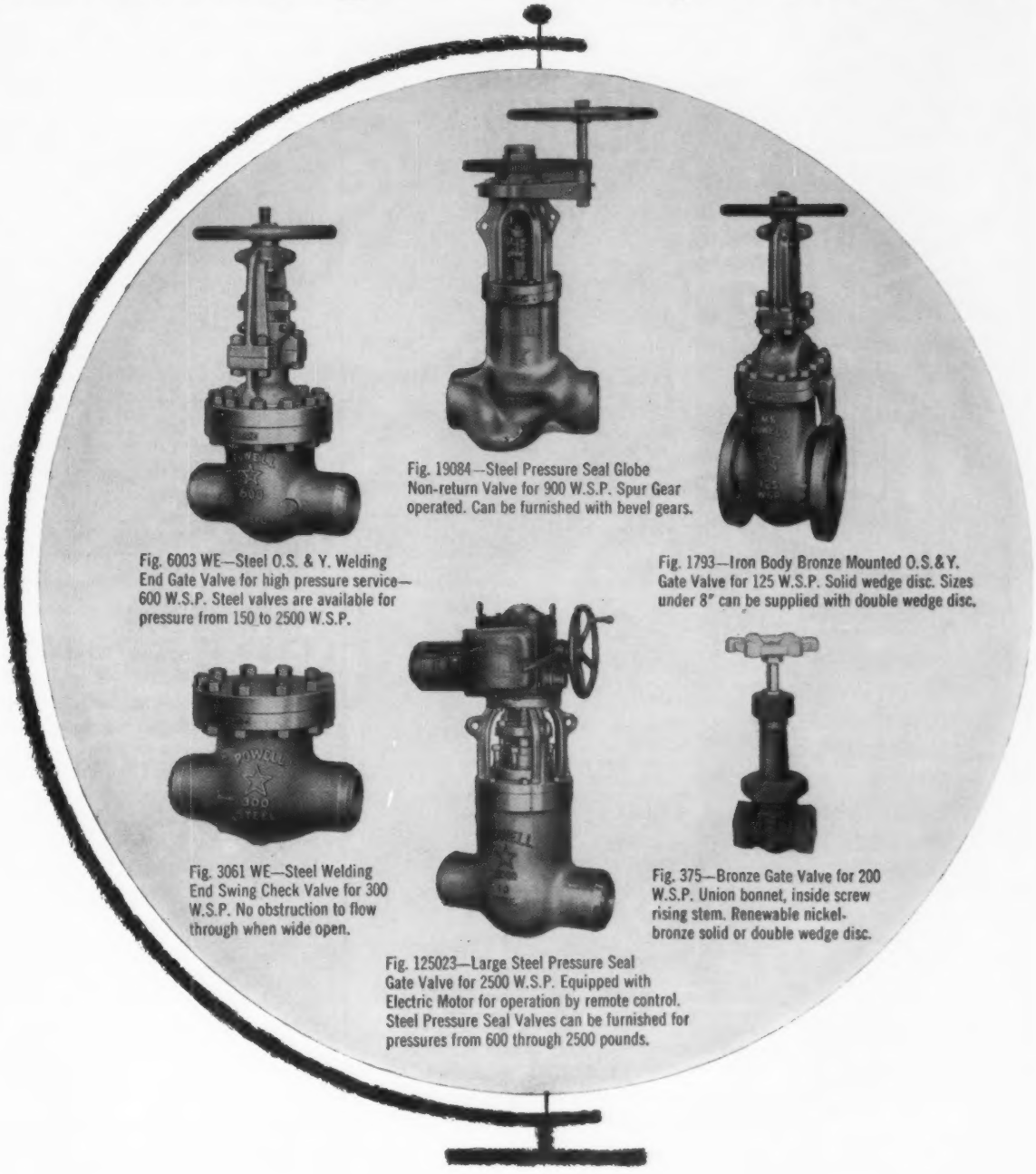


Fig. 19084—Steel Pressure Seal Globe Non-return Valve for 900 W.S.P. Spur Gear operated. Can be furnished with bevel gears.

Fig. 6003 WE—Steel O.S. & Y. Welding End Gate Valve for high pressure service—600 W.S.P. Steel valves are available for pressure from 150 to 2500 W.S.P.

Fig. 1793—Iron Body Bronze Mounted O.S.&Y. Gate Valve for 125 W.S.P. Solid wedge disc. Sizes under 8" can be supplied with double wedge disc.

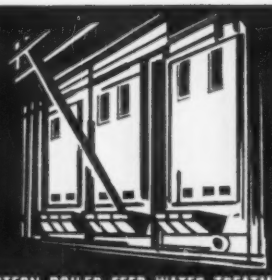
Fig. 3061 WE—Steel Welding End Swing Check Valve for 300 W.S.P. No obstruction to flow through when wide open.

Fig. 375—Bronze Gate Valve for 200 W.S.P. Union bonnet, inside screw rising stem. Renewable nickel-bronze solid or double wedge disc.

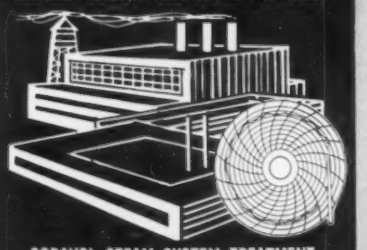
Fig. 125023—Large Steel Pressure Seal Gate Valve for 2500 W.S.P. Equipped with Electric Motor for operation by remote control. Steel Pressure Seal Valves can be furnished for pressures from 600 through 2500 pounds.

**FOR EVERY FLOW CONTROL PROBLEM** Powell offers more kinds or types of valves, available in the largest variety of metals and alloys, to handle every flow control requirement. Your local valve distributor will be glad to tell you all about them. Or write to us for the full facts.

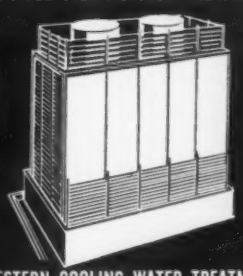
**THE WM. POWELL COMPANY** • *Dependable Valves Since 1846* • **Cincinnati 22, Ohio**



WESTERN BOILER FEED WATER TREATMENT



CORAVOL STEAM SYSTEM TREATMENT



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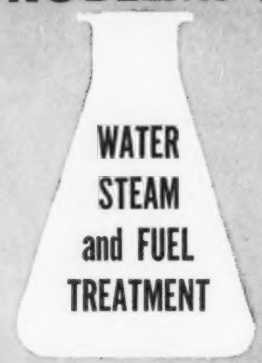


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# Appointments

## Corporation changes

**Crouse-Hinds Co:** Robert J Sloan, president. **Morse Chain Co:** Robert O Bass, president and general manager. **Crosby Valve & Gage Co, Inc:** William P Husband Jr, chairman; Charles F Dempsey, president. **Triangle Conduit & Cable Co, Inc:** John E McAuliffe, chairman; Joseph G Slater, president.

## New distributors

For **Olin Mathieson Chemical Corp:** A M Castle & Co. For **National-U.S. Radiator Corp,** Cyclotherm Div: E Paul Harder Asso, St. Louis, Mo. For **Automatic Switch Co:** Frank D Riggio Co, Inc, 31 State Highway 17, Rutherford, N. J.

For **Carrier Corp:** A T Distributors, Memphis, Tenn. For **Ampco Metal, Inc,** Pump Dept: C J Breitenstein, 7775 Sheridan Drive, Buffalo 21, N. Y.; L Casey, 106 Archer Rd, Syracuse 4, N. Y.

## Institute elections

**National Electrical Week Committee:** N J MacDonald, chairman. **American Welding Society:** Gustav O Hoglund, president; Charles I MacGuffie, first vice-president. **Consulting Engineers Council:** Charles C Pate, president.

**Polytechnic Institute of Brooklyn:** Dr Ernst Weber, president. **Internal Combustion Engine Institute:** L F Shoemaker, president.

## Awards

**Arthur M Harrison,** Westinghouse Electric Corp; **Clement S Schifreen,** cable and insulation research engineer; **Millard C Westrate,** Commonwealth Asso, Inc: elevated to grade of Fellow of the AIEE.

**Robert C Dickinson** and **Russell E Frink:** $10,000 patent award of Westinghouse Electric Corp.

**George H Miehls,** Albert Kahn Associated Architects & Engineers: Distinguished alumnus award of Ohio State U.

**Prof Robert Salmon Hutton,** General Electric Co: Institute of Metals Medal in Platinum for work in nonferrous metallurgy.

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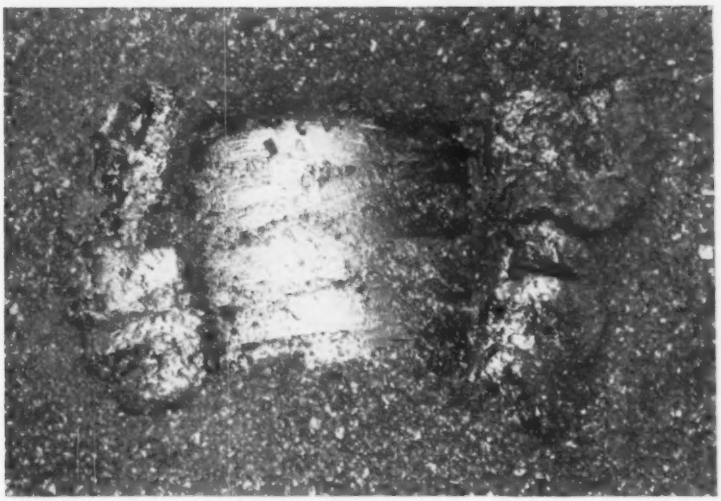
## 3-WAY PROTECTION SYSTEM

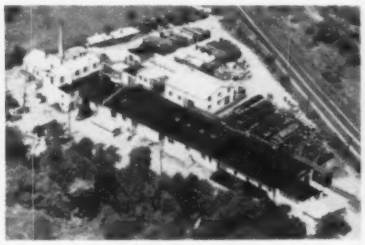


## FOR UNDERGROUND HOT PIPES

**Tri-sul-ite, a specially selected gilsonite, is poured under and around all pipes in the trench. After proper curing, it forms three zones of protection against water, corrosion and heat loss. Above, close-up photo shows Type I (For pipe temperatures between 220°-300°F.) Tri-sul-ite installation at large Southern university ··· the plastic material which adheres to the pipe, the sintered and the loose granular Tri-sul-ite zones can be observed.**

The G. S. Ziegler Company built its own executive office building at Great Neck, N. Y.

One of the many veins of pure gilsonite in Utah, owned by our company.



The G. S. Ziegler main processing plant at New Market, N. J.

Type II Tri-sul-ite ready for shipment at our Craig, Colorado, facilities.

One of the several G. S. Ziegler specialized laboratories at New Market, N. J., where product improvement is a continuous research project.

**MINERAL RESOURCES, OPERATING FACILITIES,**
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**CREATE SATISFIED CUSTOMERS**

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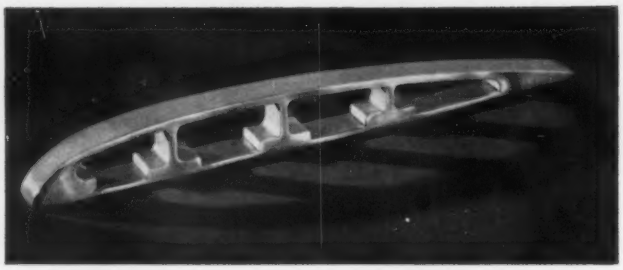
**GREAT NECK, N. Y.**

Agents in Principal Cities Throughout the United States and Canada.

MINES: "CASTLE PEAK," "LITTLE BONANZA," "LITTLE EMMA."



Cross section shows structural superiority of Aeromaster's new, extruded aluminum-alloy blades in diameters from 9′ to 22′.

# NEW! EXTRUDED ALUMINUM Blades on AEROMASTER* fans only

AEROMASTER'S new, extruded aluminum blades combine in one design the advantages of a light weight metal, a hollow structure and the superior strength of wrought metal... Silicon-magnesium aluminum alloys resist corrosion. Their fine grain structure, high tensile strength and increased endurance limit eliminate danger from wear, vibration, and metal fatigue . . . true airfoil blade sections assure maximum air delivery . . . adjustable blade pitch angle permits decrease of fan load to an accurate minimum horse-power requirement.

The AEROMASTER fan is easily assembled *in the tower*. No special handling equipment is necessary. AEROMASTER fans cost less to install, less to operate, less to maintain!

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Aeromaster Fans

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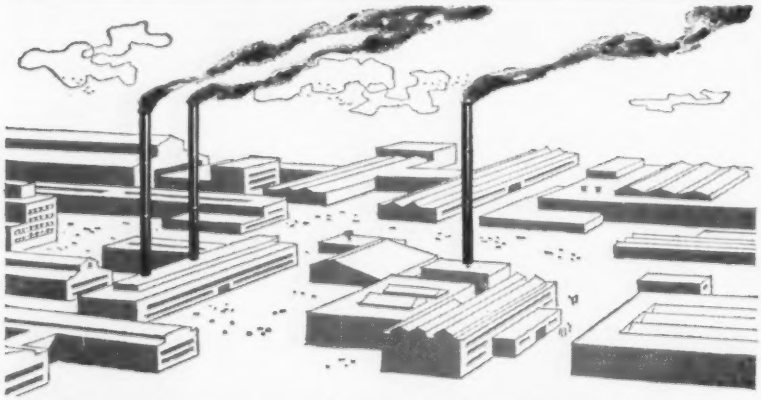

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*Permaglas*® smokestacks are glass-protected(inside and out)... are virtually impervious to condensate corrosion

* Accelerated life tests prove that *Permaglas* stacks last 3 to 5 times longer than plain steel stacks

* *Permaglas* stacks are easy to install—no special equipment needed

Write for the money-saving facts . . . get Bulletin SS-202

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PERMAGLAS SMOKESTACK SALES
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Gentlemen: Please send me a copy of the Permaglas Smokestack Bulletin No. SS-202.

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City_____ Zone_____ State_____

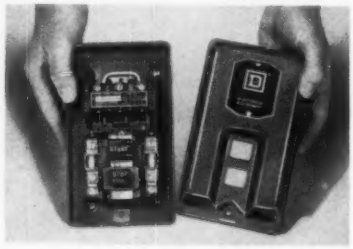

## Equipment news

Begins on page 140

### Chronograph-slide rule

**712** • Circular slide rule built into this watch can be used to calculate multiplication, division, ratios, exchange, conversion.

The instrument has an all-steel case, 17-jewel movement, 60-second and 45-minute registers, a dial with raised silver figures. It also comes in a solid gold case.—*Wakmann Watch Co, Inc, 15 W 47th St, New York 36, N. Y.*



### Manual starter

**713** • Integral-horsepower units in NEMA sizes 0 and 1 are for control of motors up to 7½ hp. Design features heavy-duty toggle-action operating mechanism which is said to give positive snap-action opening and closing of contacts with no dead-center position.

Rated up to 600-v ac or 250-v dc, starters come in 2, 3 or 4-pole construction.—*Square D Co, 4041 N Richards St, Milwaukee 12, Wis.*

For more details on these items, use post cards p 145. Identify your request with item number.

### Color-coded packings

**714** • Mechanical packings for chemical processes are color coded for positive service identification, mix-up prevention, simplified inventories.

Three styles cover the full pH scale. There is a blue packing for strongest acids, in which each blue asbestos fibre is multicoated with a Teflon concentrate. For sealing mild

# Extensively used in the rocket and missile industry–

**Here are precision products for a precision industry ... Marsh products that are *fully approved* and widely used thoughout the aircraft and missile industry:**

## PRESSURE GAUGES

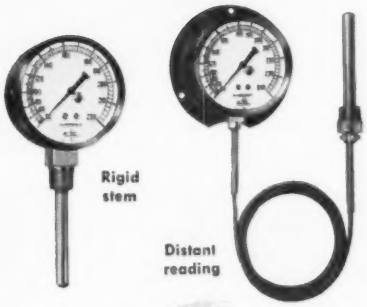
The Marsh "Mastergauge"

Accepted throughout industry as "the standard of accuracy," Marsh Gauges are the final solution to your most difficult and exacting problems. Recent Marsh developments are: Fusing of socket and bourdon tube into one-piece leak-proof unit by Marsh "Conoweld" process; "Marshalloy" case, lighter, stronger, more corrosion resistant; finer movements, safety cases, and many other unduplicated features. All Marsh Gauges are available with the Marsh "Recalibrator." There is a Marsh Gauge for practically every conceivable purpose—pressure, vacuum, compound.

## NEEDLE THROTTLING VALVES

In the Marsh Needle Valve you have the answer to your need for a valve giving micrometer throttling and positive shut-off at *high* pressures—any pressure up to 10,000 psi—with equally precise regulation at any lower pressure. Today they are available in 416 stainless steel throughout with "Teflon" packing which is unimpaired by the most powerful solvents, acids and alkalies, even at temperatures up to 500° F. Suitable for oxygen, helium and high pressure air. Available in panel mounted pattern.

## DIAL THERMOMETERS




The most versatile and accurate type of bourdon tube thermometer has been brought to its highest development in the broad, highly adaptable Marsh line. Accurate readings, even when the dial is located far from the point of measurement, is assured by the vapor tension principle. The Marsh line is a complete line—wide temperature ranges; many dial sizes; case patterns; finishes. All have the famous Marsh "Recalibrator"—handiest and best way to keep an instrument accurate.

Up to the minute facts on all Marsh products are yours for the asking.

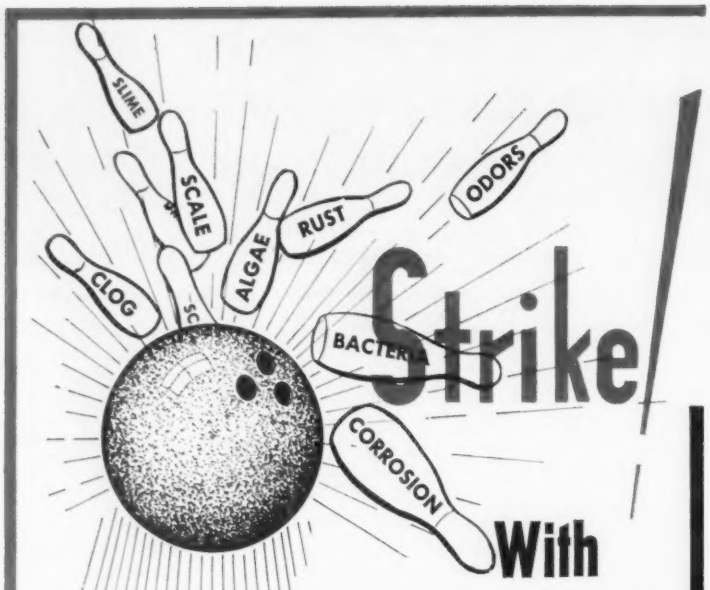
**All Marsh products available with AND threads**

*New Catalog Covers all details*

# MARSH

THERMOMETERS • GAUGES • VALVES

**MARSH INSTRUMENT CO.** *Sales Affiliate of Jas. P. Marsh Corp.,* **Dept. F, Skokie, Ill.**
Marsh Instrument & Valve Co., (Canada) Ltd., 8407 103rd St., Edmonton, Alberta, Can.
Houston Branch Plant: 1121 Rothwell St., Sect. 15, Houston, Texas

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MEMPO PRODUCTS are part of the DEADY COMPLETE WATER TREATING PROGRAM for Cooling Water treatment which insures maximum efficiency of your cooling system. MEMPO PRODUCTS are available in crystal, liquid or powder forms.

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Service Engineers in: Chicago, Charlotte, Chattanooga, Cincinnati, Davenport, Denver, Detroit, Ft. Wayne, Indianapolis, Kansas City, Los Angeles, Memphis, Milwaukee, Minneapolis, Omaha, Pittsburgh, St. Louis, San Francisco, Seattle, Toledo, Tulsa.

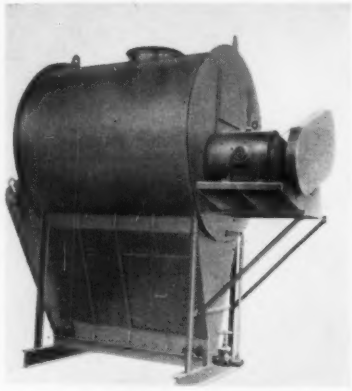

## Equipment news

Begins on page 140

acids and mild alkalies, a black graphited braided-asbestos packing is used. For strong caustics and other alkalies there is a white packing made of a multicoat of Teflon over asbestos fibres.

A brown color-coded packing can be used over the entire pH scale from sulfuric acid to sodium hydroxide, according to manufacturer. It is woven of 100% filament Teflon yarn.—*A W Chesterton Co, 6 Ashland St, Everett 49, Mass.*

For more details on these items, use post cards p 145. Identify your request with item number.



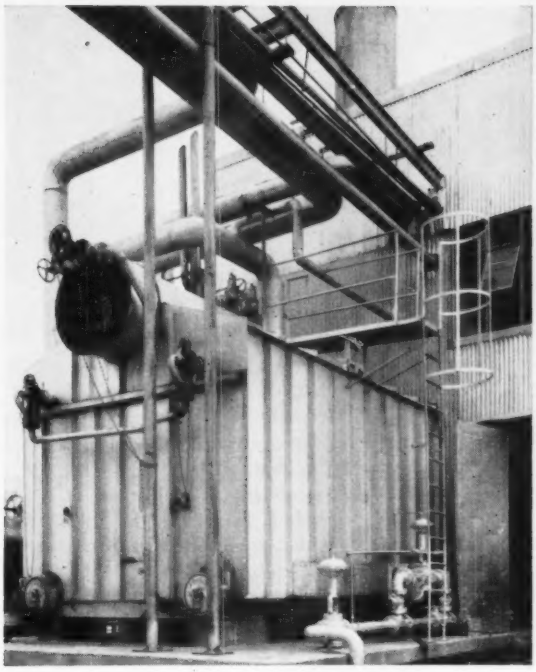
### Hot-gas washer

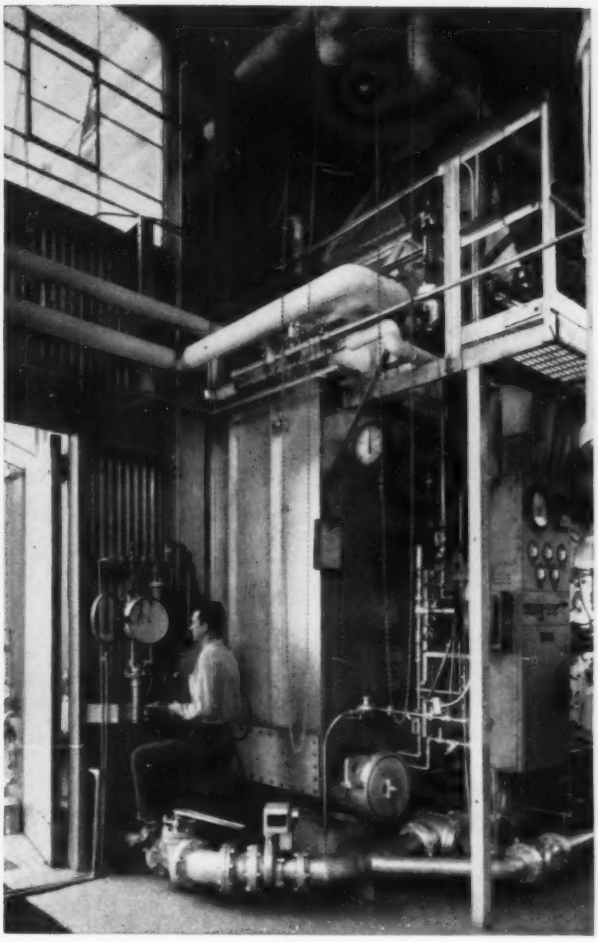
**715** • Single-unit hot-gas washer eliminates most air-pollution problems and resists temperatures up to 2000 F, according to manufacturer. Compact unit is less than 15-ft high, and can be used for incinerators, melting furnaces, chemical processes and other conditions where hot air or gases present a dust-pollution problem. Comes with manual or automatic sludge removal.—*Lehigh Fan & Blower Div, Fuller Co, Catasauqua, Pa.*

### Flexible lacing

**716** • High-strength flexible lacing is for troughed conveyor-belt use. Designed for quick, simple installation, heavy-duty hinge-type splice is

*Processing wallboard at Kaiser Gypsum*





# Union Packaged Boiler takes increased load in stride

A good part of the steam for processing gypsum wallboard at Kaiser Gypsum Company's Long Beach plant is supplied by the 35,000 lb./hr. Union Type MH Packaged Boiler shown.

Semi-automatic fired with a normal operating pressure of 200 psi, this compact unit went on the job in 1956. Installed outdoors, it eliminated the need for further extension of the existing boiler house.

Although originally furnished to deliver steam for 2 out of 5 zones in a Coe Dryer, the MH was later hooked up to carry more of the load handled by an older boiler. Says the engineer-constructor, Kaiser Engineers: "The extra load demand on the Union Boiler was hardly noticeable from an operating standpoint."

Throughout industry, similar reports verify reliable Union performance on stiff assignments. Job-proved designs, complete shop assembly, compactness, easy installation and above average efficiency combine to make Union MH Steam Generators the best dollar-for-dollar buy on the market.

Available in sizes from 10,000 to 60,000 lbs./hr., standard packaged units can be readily equipped to handle a great diversity of needs formerly requiring costly field erection and special engineering.

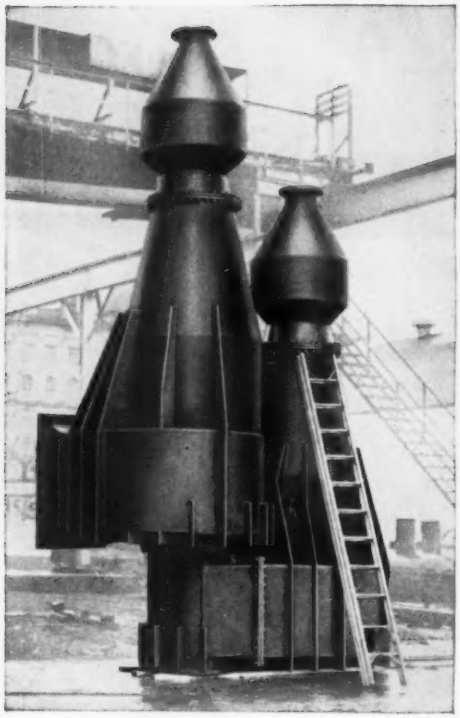
**GET FULL DETAILS**

on Union packaged boilers. Write for Bulletin MH 353 with cut-away illustrations, tube layouts and dimension tables.

UNION

**UNION IRON WORKS**

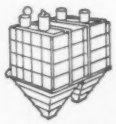
ERIE, PENNSYLVANIA



# Exploring new frontiers!

But these aren't satellite launchers, though they're specially designed for high temperature operation: they're Buell extra-efficient cyclone dust collectors . . . and the new frontiers they're exploring are in industry. Everywhere in American industry, from cement mills to refineries, from chemical plants to power generating stations, Buell collectors set new records in percentage of dust removed, low maintenance, and improved plant operation. Even in the age-old field of fly ash collection, Buell extra efficiency pays off. Only *Buell* cyclones have the unique Shave-off port that traps small fines in the double eddy currents. And Buell large-diameter design eliminates bridging, clogging, or plugging. *All three* Buell Systems are illustrated and described in "The Collection and Recovery of Industrial Dusts". Write for a copy to Dept. 50-G, Buell Engineering Company, Inc., 123 William St., New York 38, N. Y.

BUELL CYCLONES



"SF" ELECTRIC PRECIPITATORS

PRECIPITATOR-CYCLONE COMBINATIONS

buell®

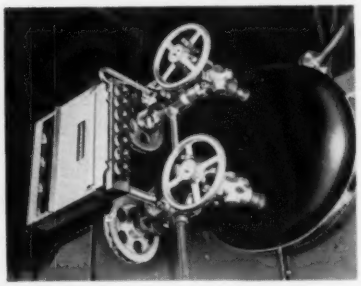
*Experts at delivering Extra Efficiency in*

**DUST COLLECTION SYSTEMS**

## Equipment news

Begins on page 140

said to eliminate need for templates, drilling or hole punching, can be installed in one piece. Available for belts from 3/16- to ¾-in. thick, up to 60-in. wide.—*General Splice Corp, 85 Spring St, South, Norwalk, Conn.*

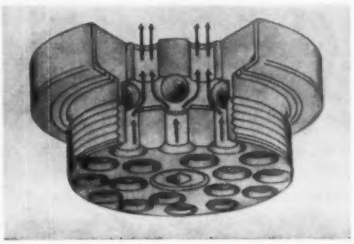


### Packaged boiler gage

**717** • Gage package is shipped as a completely welded assembly, shop tested to full boiler-design steam pressure. Installation requires only two field welds to drum connections, maker states.

Shutoff valves of locking type are provided in series with gage valves. Unit comes for 21-in. and 27-in. center-to-center boiler connections in both integral-tie-bar and support-tube construction, for parallel or normal viewing.—*Diamond Power Specialty Corp, Lancaster, Ohio.*

For more details on these items, use post cards p 145. Identify your request with item number.



### Compressor ball valves

**718** • Suction and discharge valves for heavy-duty ammonia compressors have replaced the flat plate or poppet with multiple steel balls. This feature gives less resistance, better seating, greater life and improved performance, according to maker. The valve is said to pass 26% more gas than conventional models.—*Ball Valve Co, 5512 Oak St, Kansas City 13, Mo.*

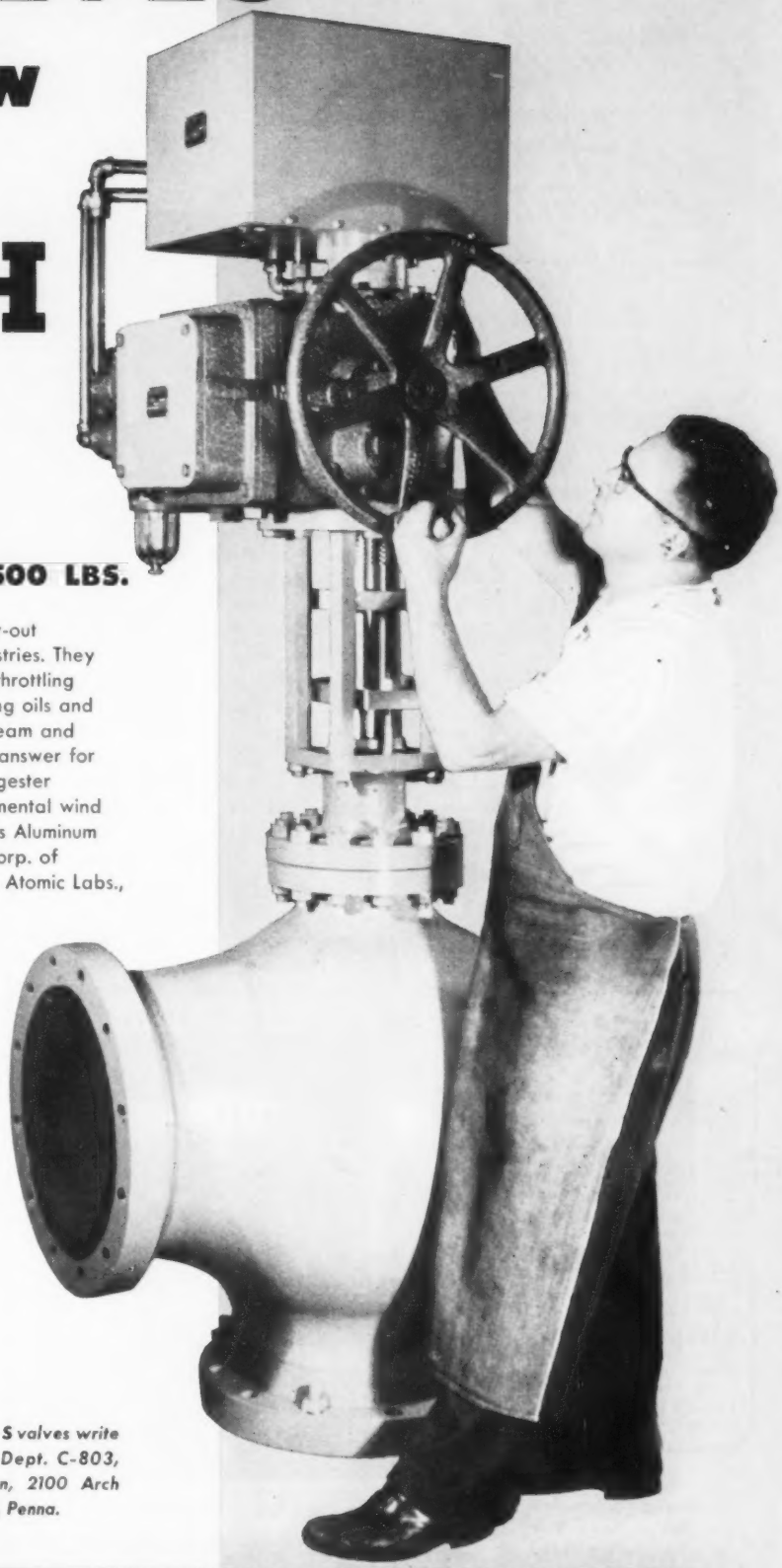
# S VALVES

## by CONOFLOW

## for the

# TOUGH

## JOBS



**SIZES TO 14"**
**PRESSURE RATINGS TO 2500 LBS.**

**S valves by Conoflow** are on day-in, day-out service handling the tough jobs in many industries. They offer unmatched performance for automatic throttling control of erosive and corrosive slurries, coking oils and liquids, and high pressure pipe line gases, steam and water. **S** valves have proved to be the final answer for such services as alumina refining, pulp mill digester relief, boiler feed water control, and experimental wind tunnels. A few well-known users are: Reynolds Aluminum Co., U. S. Steel, Humble Oil Co., Aluminum Corp. of America, Texas Co., Redstone Arsenal, Knolls Atomic Labs., and Olin-Revere Metals Corp.

**The difference is in the design...**
The patented, single-seated **S** valve is of heavy, rugged construction throughout. Extra body wall thickness, streamlined contours and heavy stem guiding make the **S** valve especially suited for high pressure drops. Venturi seat ring and parabolic plug assure tight shut-off. Self-sealing bonnet is leakproof. Sizes 1" through 4" carry ASA ratings to 2500 lbs.; sizes 6" and 8" to 1500 lbs. ASA; sizes 10", 12" and 14" to 300 lbs. ASA.

*For complete data on S valves write for Bulletin S-1 to Dept. C-803, Conoflow Corporation, 2100 Arch Street, Philadelphia 3, Penna.*

Conoflow Controls®

**CONOFLOW CORPORATION**

*FOREMOST IN FINAL CONTROL ELEMENTS*

Catawissa
PERFECT SEAL
Unions

HOT FORGED from solid, rectangular steel bars, designed and produced for dependable, long-life service under the severest piping conditions!

A TYPE FOR EVERY USE!
FOR ALL PRESSURES!
FOR ALL TEMPERATURES!

Standard & Double Extra Heavy
UNIONS

Available with screwed or socket weld ends. 3000-lb. sizes ⅛" to 3"; 6000-lb. sizes ⅛" to 2".

ORIFICE UNIONS

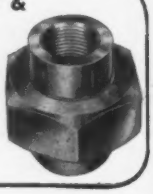
With screwed or socket weld ends. 3000-lb. and 6000-lb. service.

MALE & FEMALE UNIONS

With steel-to-steel, bronze-to-steel, stainless steel-to-steel or orifice seats. 3000-lb. service only.

FULL STAINLESS & FULL ALLOY STEEL UNIONS

With screwed or socket weld ends. 3000-lb. and 8000-lb. service.



WRITE FOR CATALOG 58
showing the complete Catawissa line of Perfect Seal Products

CATAWISSA VALVE AND FITTINGS COMPANY
206 Mill St. • CATAWISSA, PA.

## Reports from the field

Begins on page 134

to point of use. A 214-mile German system has successfully operated at 400 kv since last October, and other systems at 420-kv maximum are in use in Sweden, France, Russia. Experimental lines have gone up to 650 kv.

U.S.S.R. has announced a planned power line 310 miles long to carry 800-kv dc, with construction already started on a large substation to transform ac to dc for transmission. Great distances to be covered in Russia without need of stepping down power lead to this dc philosophy, and their engineers find dc transmission cheaper construction- and operation-wise, on this long-distance basis.

With transmission voltages constantly edging higher, the h-v involvement may well be reflected all down the line. For in-plant distribution, design engineers haven't forgotten that $W = EI$; higher voltages mean more power can be carried by smaller cable, and with lower losses.

In yesterday's plant, h-v, like leprosy, was held at a distance. But modern engineering has moved high voltage indoors; the past years have taught us to live with voltages rising from 2.3 to 13.2 and most recently to 69 kv. More dependable equipment, greater degree of safety enclosure, better all-round know-how may lead to even higher voltages for tomorrow's in-plant distribution.

### Engineers gather for oil-, gas-power discussion

Happy engineers, above, are looking over an industrial gas-turbine rotor

GET FACTS YOU SHOULD KNOW ABOUT TUBING

NEW TUBING DATA BOOK FREE!

Complete technical data for designers, plant engineers, purchasing agents. Specifications, applications, and how to order interlocked and corrugated flexible tubing, vibration absorbers, expansion joints.

It's a book you need to improve your knowledge of tubing. Yours free. Send request on company letterhead to Dept. 106, Pennsylvania Flexible Metallic Tubing Co., 7237 Powers Lane, Philadelphia, Pa.

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PENFLEX
TIGHT AS A PIPE BUT...
FLEXIBLE

## Another new development by Iron Fireman

# MicroMist
TRADE MARK

HEAVY OIL BURNER

TWO-STAGE ATOMIZER CHANGES HEAVY OIL TO AN AERATED FOG, WITH THE CHARACTERISTICS OF A GAS—NOT A SPRAY

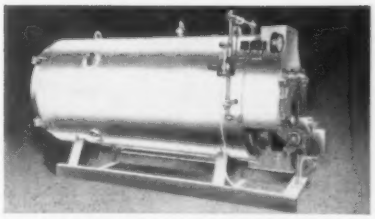
# *Now* a medium size burner that fires low cost oils

### New two-stage atomizing principle

The heart of the Iron Fireman MicroMist burner is an ingenious compressor-atomizer. The compressor reduces the oil to an air mixed spray (which is as far as other burners go) then by the heat of compression, into an air-oil vapor. The oil is so finely divided that it becomes an oil mist or fog that will remain in suspension for several hours. It is easily and directly ignited by an electric spark (does not require gas ignition). Now medium size heating plants (previously restricted to light, expensive oils) can switch to low cost heavy oil with substantial savings in fuel costs.

### Note these additional features

The Iron Fireman MicroMist burner is as easily installed as a conventional gun type burner. It has two important uses. (1) As a conversion burner with any type of boiler. No special boiler front is required. (2) As a component part of a packaged boiler-burner unit. The choice of oil grades is almost unlimited (from No. 5 down to the lightest fuel oils). Integral control panel is wired and tested at the factory. Fuel and maintenance costs are low. Eliminates frequent nozzle inspection and cleaning, because of the large orifice to disperse the oil mist. Fires low-cost, heavy oils with little more attention than a domestic oil burner.



**Available as a complete package ready to operate . . . Scotch boiler, burner, controls**

Installation requires little more than service connections. Easily specified from catalog list of sizes and capacities. Available for either natural or forced draft. Firing unit can be ordered separately for installation in any type of boiler.

*Send for more information*

**IRON FIREMAN**®

AUTOMATIC FIRING EQUIPMENT
FOR HEATING, POWER, PROCESSING

IRON FIREMAN MANUFACTURING CO.
3038 W. 106th Street, Cleveland 11, Ohio
(In Canada, 80 Ward Street, Toronto, Ontario)
Please send me more information and specifications on the Iron Fireman MicroMist burner.

Name_____
Firm_____
Address_____
City_____ Zone____ State_____

THIS *NEW* CATALOG...

explains how

**LONERGAN**

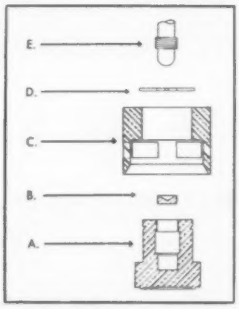
**STEEL NOZZLE VALVES**

**save more money than ever!**

Now, not only do LONERGAN Steel Valves (with the patented Ported Reaction Disc) offer the same high degree of control and efficient performance, but . . . there is a new PLUS feature which actually reduces maintenance costs to a bare minimum!

The Two-Piece Disc is machine lapped to optical flatness . . . at the factory. Also, this can be done in the field . . . or, a replacement Disc may be purchased at very low cost.

Full details on the complete line of LONERGAN Steel Valves contained in our new Catalog 1000-V . . . ask for a copy, on your business letterhead, please.




**LONERGAN 2-PIECE PORTED REACTION DISC**

- **A** The disc proper, whose seats are lapped on a lapmaster.
- **B** A hardened steel seat offering a uniform surface for the ball pointed stem.
- **C** The disc holder into which are machined the parts and the conical baffle which skirts disc.
- **D** Tru Arc Ring which holds the disc in the holder.
- **E** Valve stem.

*ESTABLISHED 1872*

Lonergan

J. E. LONERGAN COMPANY

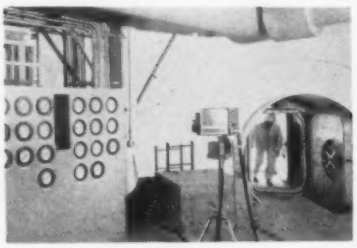
2nd & Race Streets
Philadelphia 6, Pa.

## Reports from the field

*Begins on page 134*

at the Westinghouse Gas Turbine Plant. Tour was part of the activities at the recent Oil and Gas Power Conference of the ASME in Philadelphia.

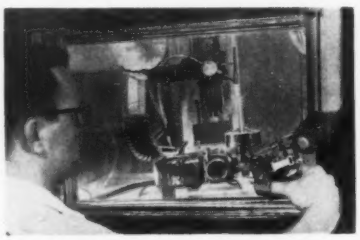
Other highlights of the conference included papers on arctic lubrication for diesels, the free-piston gasifier, maintenance of fuel-injection systems and charge stratification for spark-ignition engines. Rear Admiral A G Mumma spoke on "The New Navy." Louis N Rowley, editor and publisher of POWER, and John A Worthington of Koppers Co, Inc, were awarded Fellow Certificates of the ASME.



### Industrial TV insures safety at the Vallecitos reactor

The Vallecitos boiling-water reactor is fitted with a General Electric Co closed-circuit television system. Camera, center, monitors recording instruments inside the reactor enclosure for the benefit of a reactor operator in another building.

Steam from the reactor powers a Pacific Gas & Electric turbine-generator installation to produce world's first privately financed atomic electricity.



### Even the radioisotopes come in cans these days

Radioactive materials now come packaged for commercial use; "canned" in Heliarc-welded stainless-steel containers.

You won't find them on your grocery-store shelf, though. Cesium-137, iridium-192 and cobalt-60 are pro-

***EVERY BUSINESSMAN KNOWS...***

***that money wasted is money we can never recover.***

And yet every day many dollars and man hours are lost in mailing rooms and post offices across the land — lost because somebody forgot (OR DIDN'T BOTHER) to include a Postal Zone Number.

**Have you . . .**

**ANY COMPLAINTS?**

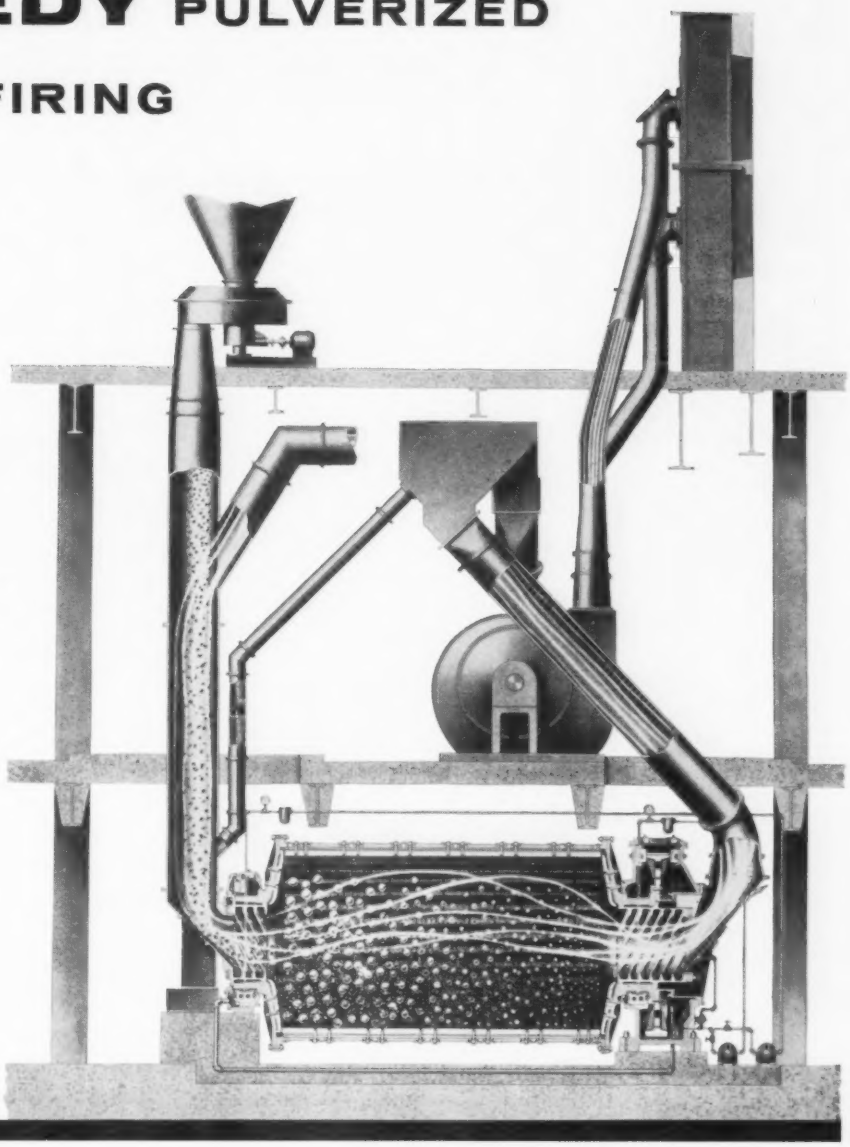
*. . . postal service?*
*. . . late delivery?*
*. . . lost copies?*
*. . . mail gone astray?*

Maybe we don't have your complete address.
A complete address includes a Postal Zone Number.

***POWER***

*330 West 42nd Street*
*New York 36, N. Y.*

# SAVE ON EVERY TON WITH A KENNEDY PULVERIZED COAL FIRING SYSTEM



**NO OTHER SYSTEM INCLUDES ALL OF THESE FEATURES...**

- Fully air swept
- Coal pulverized to superfineness
- Coal completely carbureted, ready for combustion
- Big trunnions for air sweeping
- Balls added without shutting down
- Low operating and maintenance costs
- 85 to 90% through 200 mesh
- 20% moisture removed while pulverizing
- Pulverizes any coal
- Tramp iron aids in pulverizing
- Reserves of fuel for fast response to demand

**A TYPICAL KENNEDY PULVERIZED COAL FIRING SYSTEM**

*The installation shown here includes a disc feeder, KENNEDY ball mill, classifier, exhauster and burners. KENNEDY Systems are designed for perfect combustion with any coal—bituminous, anthracite or coke.*

KENNEDY saves you dollars through the use of low grade, low cost coal, pulverized to superfineness for instant response to varying load conditions! Hundreds of KENNEDY Systems throughout the world are providing unusually high steam and power plant economies. It will pay you to consult a KVS engineer for actual operating data. He will give you the "facts that count" in saving money with pulverized coal.

Send for more information about KENNEDY Pulverized Coal Firing Systems.

KVS

**KENNEDY • VAN SAUN**

MANUFACTURING & ENGINEERING CORPORATION

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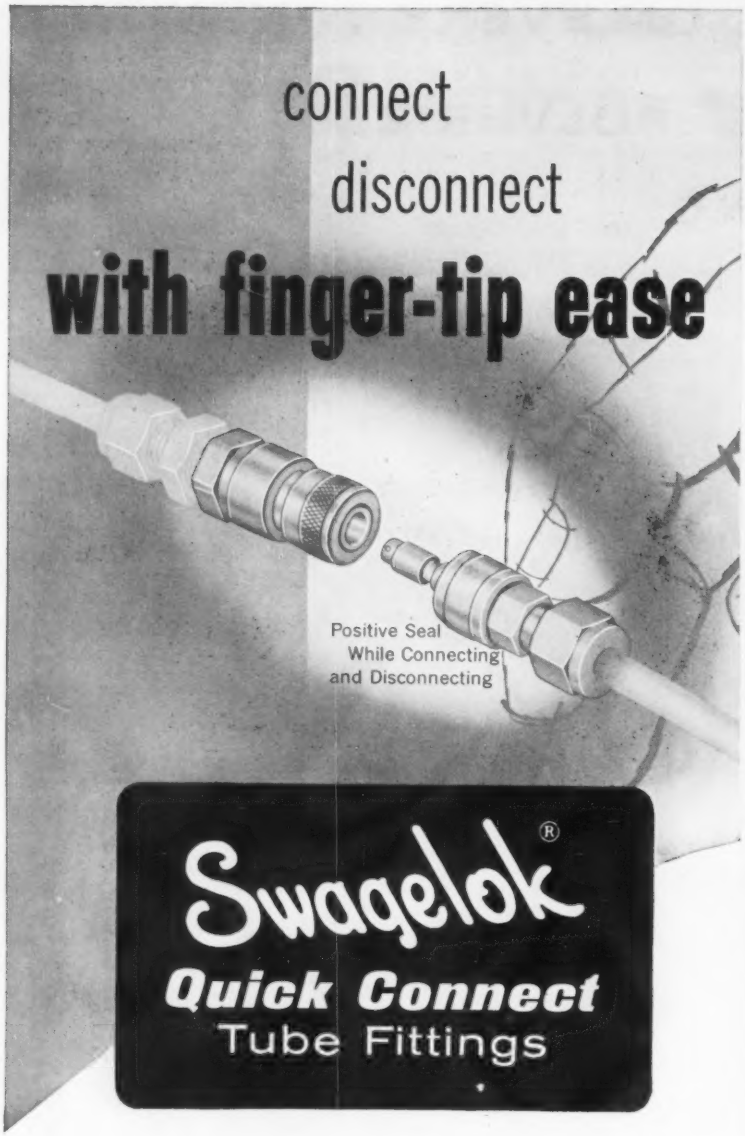


With Swagelok Quick Connect there is no pressure drop during disconnection . . . no loss of pressure when the unit is disengaged.

Compact design and swivel rotation at sealing point of Quick Connect permit greater mobility with portable units.

Swagelok Quick Connects can be used with both metal and plastic tubing.

**For additional information write Dept. E-4**

**CRAWFORD FITTING COMPANY** · 884 East 140th Street · Cleveland 10, Ohio


## Reports from the field

Begins on page 134

duced at Oak Ridge National Laboratory for use in hospitals, industry.

The remotely controlled welding assembly is placed in a shielded cell equipped with mechanical manipulators, p 182. The containers consist of two parts; an inner cylinder to hold the radioactive material and an outer steel jacket to hold the cylinder.

In the initial production run at the Laboratory, remotely controlled Heliarc process, developed by the Linde Co, div of Union Carbide Corp, was used to seal 34 capsules containing a total of 3000 curies of radioactive cobalt.

### Alabama Power Co awards hydro turbine contracts

As part of its hydroelectric-power development program, the Alabama Power Co recently awarded two hydro-turbine contracts to Allis-Chalmers Mfg Co.

One contract is for a 111,500-hp 210-ft-head 138.5-rpm francis turbine for the Warrior River project near Jasper, Ala. The other calls for two 39,100-hp 49-ft-head 90-rpm fixed-blade propeller turbines for the Weiss Dam plant on the Coosa River.

## Calendar of Events

**August 18-21—American Society of Mechanical Engineers** and **American Institute of Chemical Engineers,** Heat-Transfer Conference. Northwestern University, Evanston, Ill. Details from ASME, 29 W 39th St, New York 18, N. Y.

**August 20-22—American Society of Civil Engineers,** Hydraulics Conference. Biltmore Hotel, Atlanta, Ga. Details: ASCE, 33 W 39th St, New York 18, N. Y.

**September 4-5 — American Society of Mechanical Engineers,** International Conference on Air Pollution. Statler Hotel, New York. Details from ASME, 29 W 39th St, New York 18, N. Y.

**September 15-17—American Institute of Electrical Engineers,** Power-Industry Computer-Application Conference. King Edward Hotel, Toronto. Details: J R Leslie, Ontario

# How to get a "custom" pump at a standard price

Here's a new line of vertical centrifugal pumps easily tailored to your exact needs.

For process transfer or heavy-duty sump service, these pumps have features which assure long trouble free life with a minimum of maintenance.

Because they're built from standard parts, delivery is fast and there is no premium charge for custom building. When you want to change pit depth or pump ratings, you merely replace necessary parts. Units may be adapted in the field. Shafts and pipe columns are available for any pump length from 2 to 20 ft. in 6-inch increments.

There are types for wet or dry pits, with capacities to 1080 GPM or heads to 290 ft. Vaporproof construction is available.

Complete details in Bulletin 726.2.

**GOULDS PUMPS, Inc., Dept. P-7C, Seneca Falls, N.Y.**
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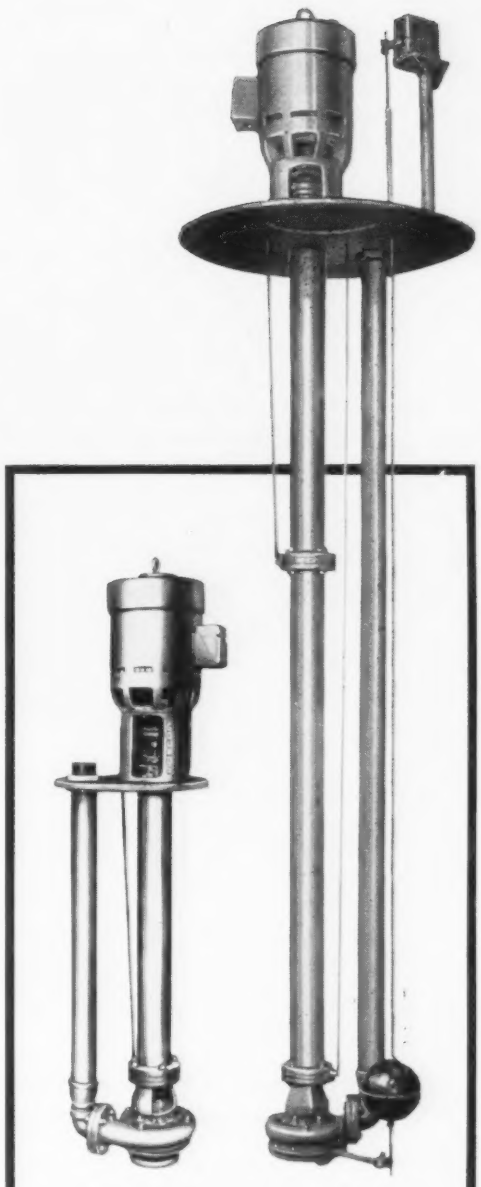

Goulds Fig. 3173 Goulds Fig. 3171

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## Reports from the field

*Begins on page 134*

Hydro, 620 University Ave, Toronto 2, Ontario, Canada.

**September 15-17—American Society of Mechanical Engineers,** Process-Industries Conference. Statler Hotel, Buffalo, N. Y. Details from ASME, 29 W 39th St, New York 18, N. Y.

**September 15 - 19 — Instrument Society of America,** 13th Annual Instrument - Automation Conference and Exhibit. Philadelphia Convention Hall, Philadelphia, Pa. Details from F J Tabery, 3443 S Hill St, Los Angeles 7, Calif.

**September 22-24—Standards Engineers Society,** 7th Annual Meeting. Benjamin Franklin Hotel, Philadelphia, Pa. Details from SES, Box 281, Camden 1, N. J.

**September 28-Oct 1—American Society of Mechanical Engineers,** Power Conference. Statler Hotel, Boston, Mass. Details: ASME, 29 W 39th St, New York 18, N. Y.

### TO OBTAIN COMPLETE TEXT

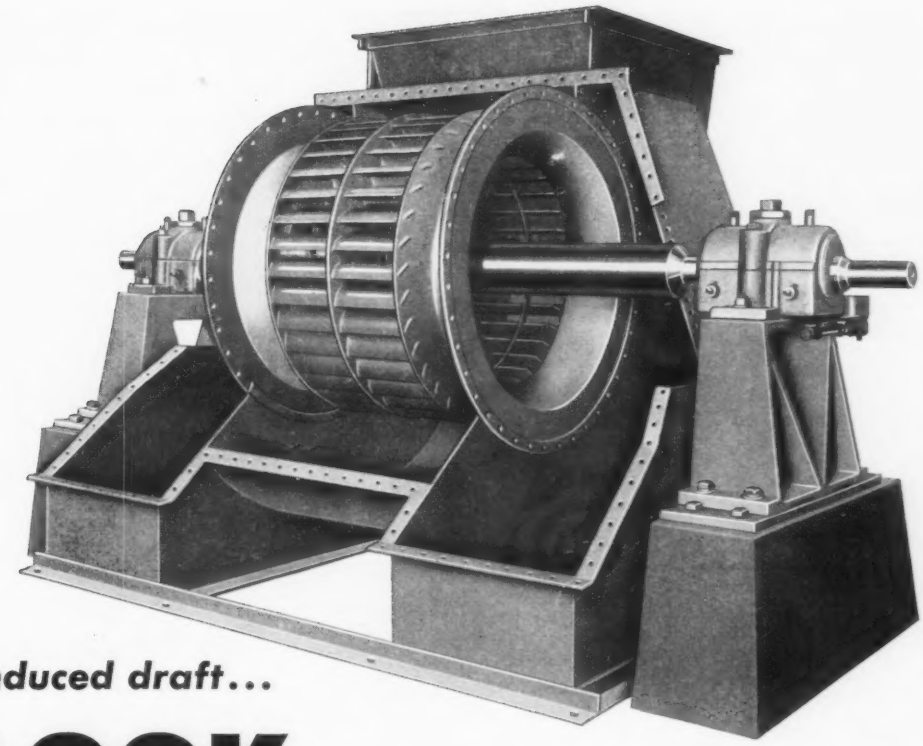
*Material for* Technical Briefs, *pages 136-38, comes from the following sources. Order complete papers from source, not* POWER.

*American Society of Mechanical Engineers. Identified by initials ASME and obtainable through ASME, 29 W 39th St, New York 12, New York.*

*Nuclear Engineering & Science Conference, Chicago, Ill. Identified by initials NESC. Available from American Institute of Chemical Engrs, 25 W 45th St, New York 36, New York.*

*American Power Conference, 20th anniversary meeting. Identified by initials APC and obtainable from Director, APC, Illinois Institute of Technology, Chicago 16, Ill.*

*American Institute of Electrical Engineers. Identified by initials AIEE and obtainable through AIEE, 33 W 39th St, New York 18, New York.*



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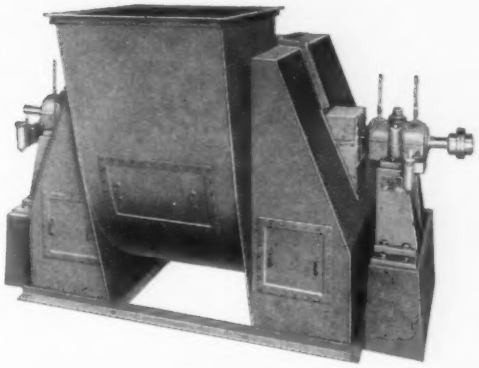

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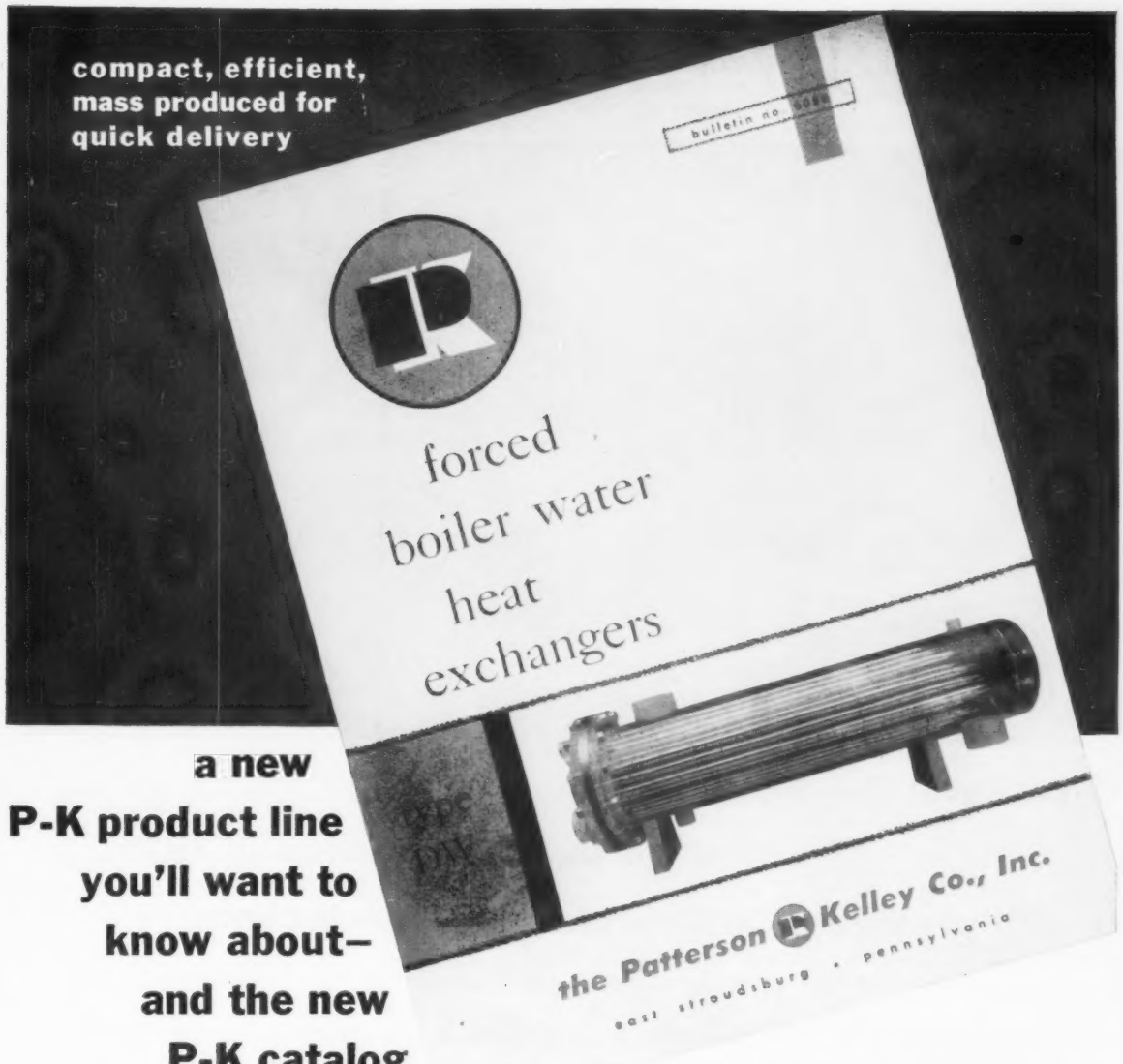


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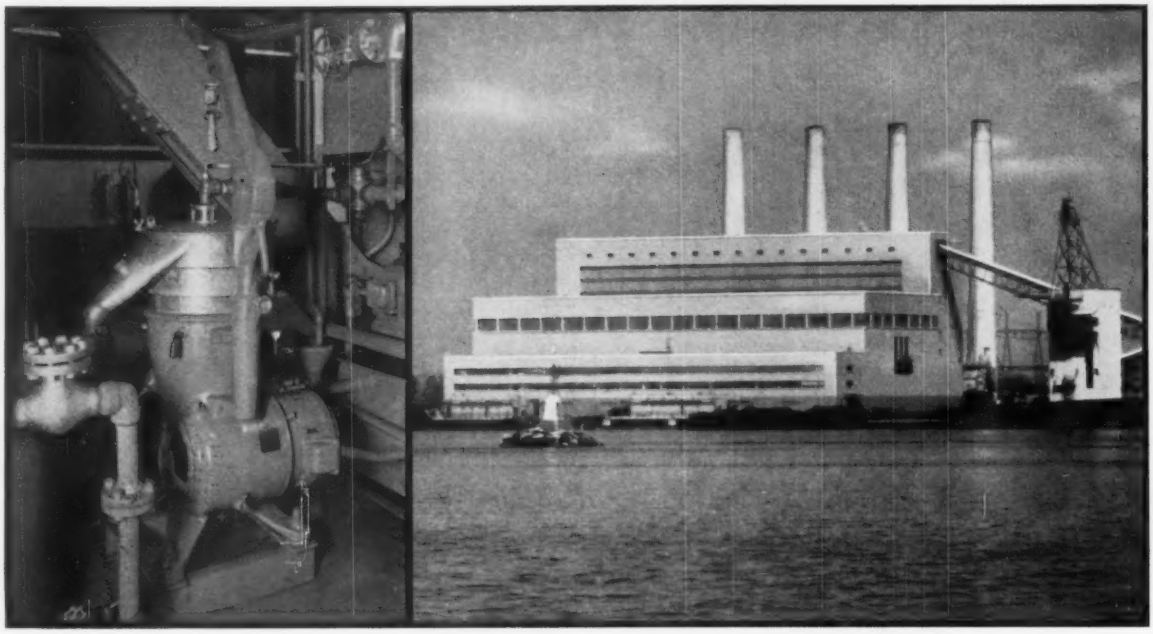

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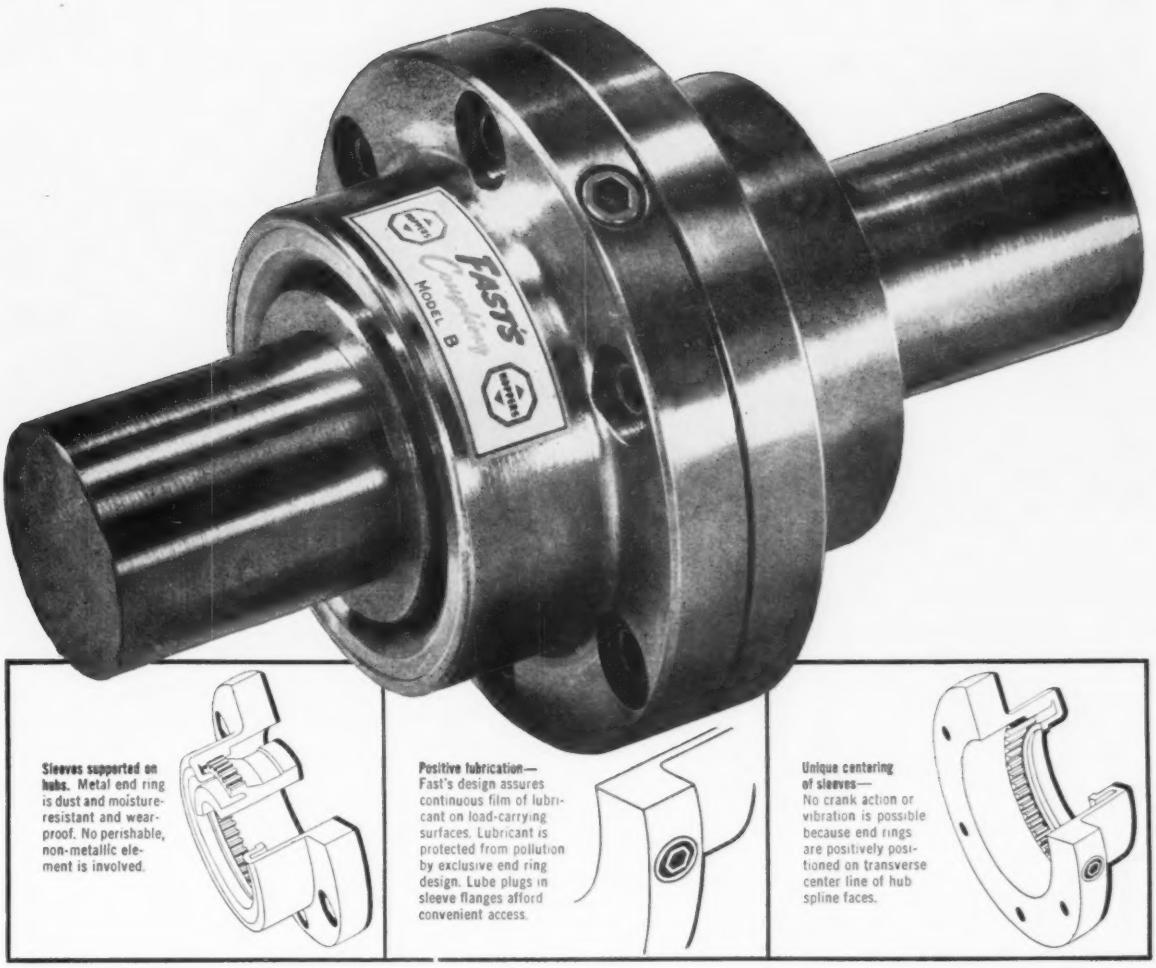
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2. Exchanges sodium for Calcium and Magnesium hardness.
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4. Uses inexpensive salt for regeneration.

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4. Uses salt plus acid for regeneration.

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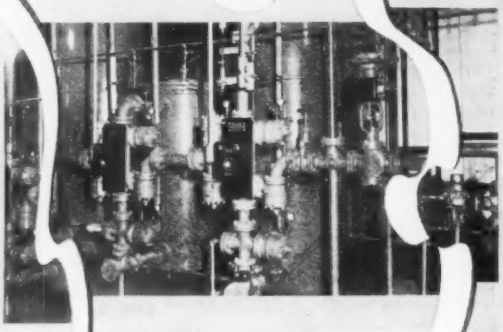
4. Uses salt for regeneration. No acid required. The addition of some caustic increases exchange efficiency, and reduces effluent $CO_2$.



**HYDROGEN EXCHANGE**

1. Softens water, liberates carbonates and bicarbonates as free $CO_2$. Acidic effluent usually requires neutralization.
2. Exchanges hydrogen for all metallic ions.
3. With degasification, reduces alkalinity and total dissolved solids.
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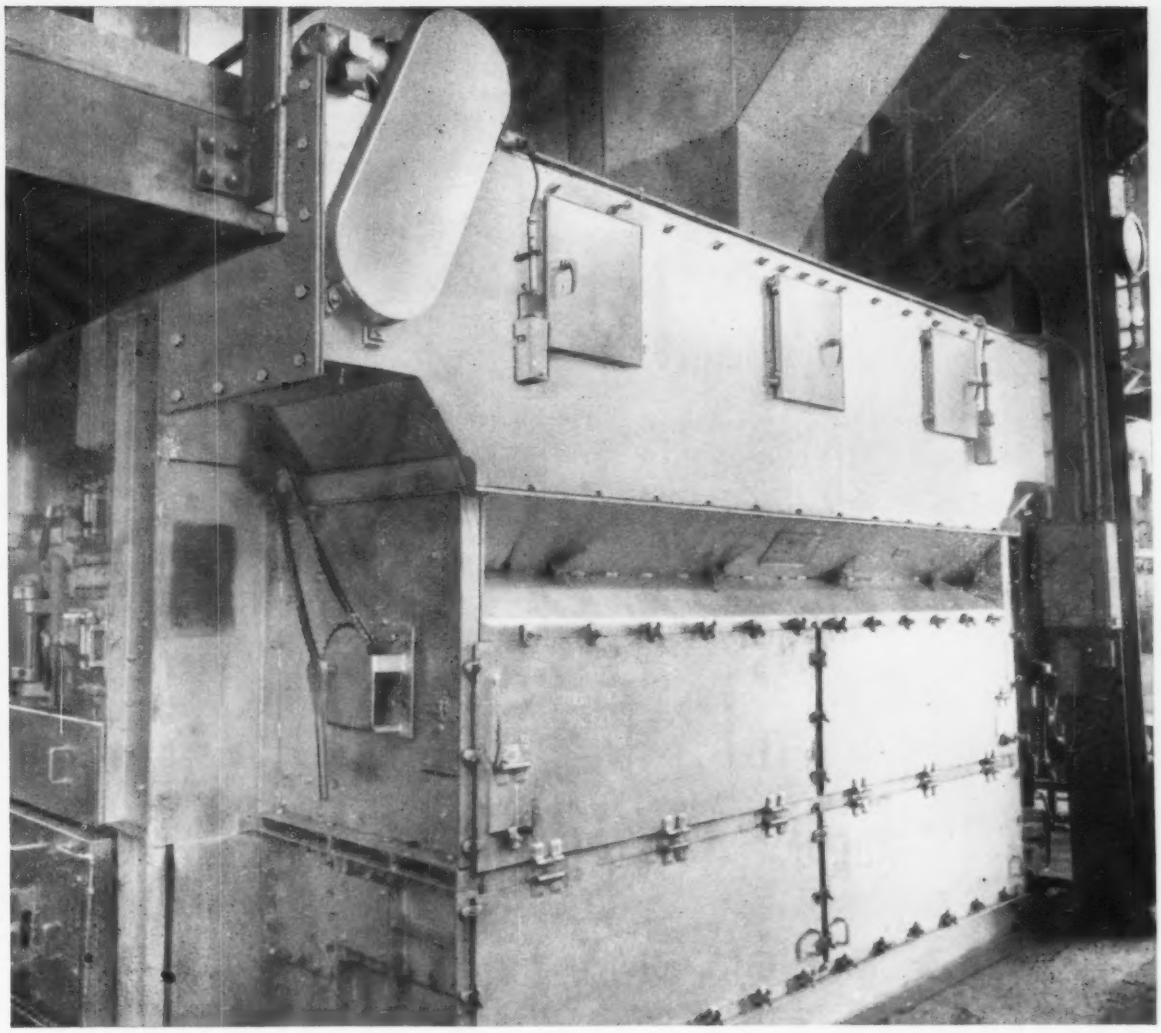

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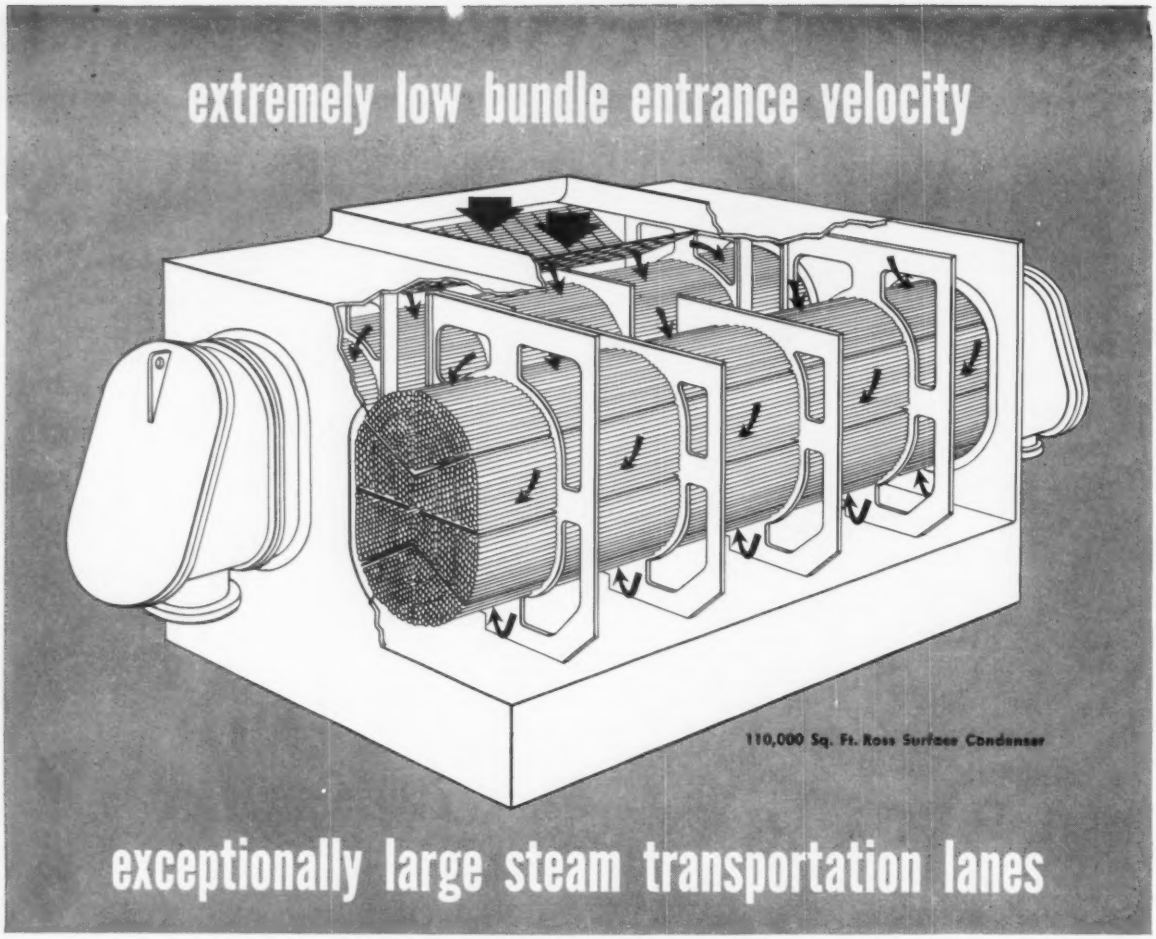
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exceptionally large steam transportation lanes

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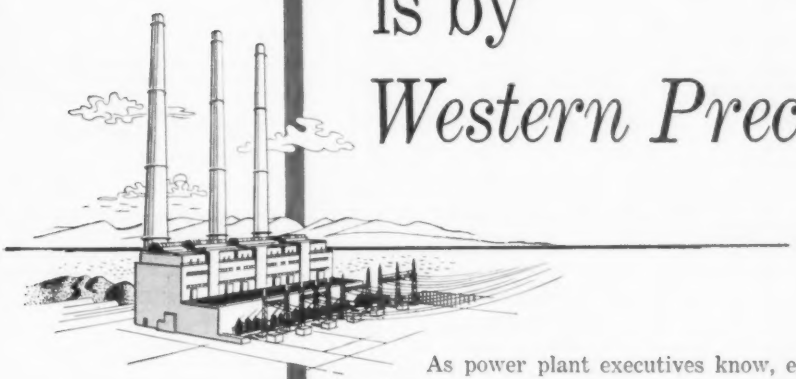

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## AIR COMPRESSORS FOR SALE
**Rebuilt, Repaired or As Is**

**PORTABLES**

1—600 C.F.M. Chicago—Diesel
2—315 C.F.M. Chicago—Diesel
1—315 C.F.M. Ingersoll—Diesel
1—315 C.F.M. Ingersoll—Gasoline
1—160 C.F.M. Schramm—Gasoline

**ELECTRIC DRIVEN**

1—4000 C.F.M. Ingersoll-700 HP, 2300/3/60 Syn. Motor
2—3000 C.F.M. Ingersoll-500 HP, 2300/3/60 Syn. Motor
3—1700 C.F.M. Ingersoll-300 HP, 2300/3/60 Syn. Motor
2—560 C.F.M. Schramm Package Units — 100 HP, 4000-2300/3/60
1—445 C.F.M. Chicago Package Unit — 75 HP, 220-440/3/60
1—260 C.F.M. Schramm Package Unit — 50 HP, 220-440/3/60

**LEO A. HARDING**
1625 Nay Aug Ave. Scranton 9, Pa.
Phones—Diamond 4-3126 or Diamond 2-2913

## GUARANTEED "REBUILT" POWER EQUIPMENT

**SQUIRREL CAGE MOTORS**
3 phase, 60 cycle, 220 or 440 volts (*2300 volts or higher)

| H.P. | MAKE | TYPE | SPEED |
|---|---|---|---|
| 1750 | *G.E. | K | 3600 |
| 1750 | *G.E. | K | 1800 |
| 1250 | *Al.-Ch. | ANX | 3600 |
| 600 | West. | CS | 720 |
| 600 | *G.E. | K-63455 | 1200 |
| 500 | *G.E. | K-63455 | 1200 |
| 500 | *G.E. | I-13-E | 900 |
| 350 | *G.E. | KT-559-A | 1800 |
| 300 | *G.E. | K6344 | 1200 |
| 250 | *W (TE) | CS-81205 | 1800 |
| 250 | *G.E. | KT-599-S | 1800 |
| 250 | *West. | CS-875-S | 1800 |
| 250 | Brook | RS28 | 1200 |
| 200 | *G.E. | FT-540 | 3600 |
| 200 | West. | I-K-13B | 1800 |
| 200 | Brook | CSP-581-S | 1800 |
| 200 | *West. | RS-27 | 1200 |
| 200 | G.E. | CS-930-A | 900 |
| 200 | *Al-Ch | KT-564-S | 720 |
| 200 | *West. | AN-37-G | 720 |
| 200 | Al-Ch | CS-1810 | 600 |
| 200 | *G.E. | ARW-631 | 600 |
| 150 | Cr-Wh | SC-140 | 3600 |

**SQUIRREL CAGE MOTORS**
3 phase, 60 cycle, 220 or 440 volts (*2300 volts or higher)

| H.P. | MAKE | TYPE | SPEED |
|---|---|---|---|
| 150 | Al-Ch | AN-30-F | 1200 |
| 150 | West. | CSP-5815 | 1200 |
| 150 | G.E. | I-K-15A | 900 |
| 150 | *West. | CS | 600 |
| 125 | Al-Ch | AR-226 | 1800 |
| 125 | G.E. | 5-Q | 1200 |
| 125 | Cr-Wh | K-558 | 900 |
| 100 | W (TE) | CS-507-S | 3600 |
| 100 | G.E. | FT-542-Z | 1800 |
| 100 | Al-Ch (TE) | ARZ-826 | 1200 |
| 100 | Al-Ch | AW-23-D | 1200 |

**SLIP RING MOTORS**
3 phase, 60 cycle, 220 or 440 volts (*2300 volts or higher)

| H.P. | MAKE | TYPE | SPEED |
|---|---|---|---|
| 2500 | *G.E. | MT (Mill Type) | 257 |
| 1100 | *G.E. | MT | 720 |
| 1000 | *G.E. | M-575-S | 1200 |

**SLIP RING MOTORS**
3 phase, 60 cycle, 220 or 440 volts (*2300 volts or higher)

| H.P. | MAKE | TYPE | SPEED |
|---|---|---|---|
| 1000 | *West. | CW | 450 |
| 600 | *G.E. | M-6345-S | 1800 |
| 500 | G.E. | M-6345 | 1200 |
| 400 | *G.E. | MTP-565 | 1200 |
| 350 | *Al-Ch | ARYW | 1800 |
| 300 | Cr-Wh | SR70-R | 1800 |
| 250 | Al-Ch | ARY-626 | 1800 |
| 250 | *G.E. | I-M-17A | 720 |
| 200 | G.E. | I-M-16 | 600 |
| 200 | *West. | CW1950A | 514 |
| 150 | Cr-Wh | SR-50R | 1800 |
| 150 | G.E. | I-M-15A | 600 |
| 125 | G.E. | I-M-15A | 800 |
| 100 | G.E. | I-E-13A | 1800 |
| 100 | G.E. | MT558 | 720 |
| 100 | G.E. | I-M-15A | 425 |
| 75 | West. | CW-770 | 1200 |
| 75 | G.E. | MT-347 | 1200 |
| 75 | G.E. | MT-356 | 900 |
| 75 | G.E. | MT-352 | 720 |
| 75 | G.E. | I-M-10 | 600 |
| 60 | G.E. | MT-356 | 1200 |
| 60 | *West. | CW-762C | 900 |
| 50 | *G.E. | MT-536 | 1200 |

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**CHICAGO** *Electric Co.*

ALL TYPES OF EQUIPMENT IN STOCK

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Differential Larry Locomotive. Mfg. #1132-1, 56½" gauge, 8-wheels, all drivers, equipped with two 125 HP, 300 volt, DC, GE 1209 motors. 19 cu. yd. cap. level—New 1949.

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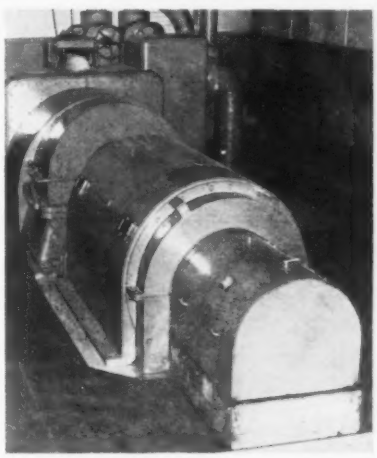

**2500 KVA POWER PLANT.** Will be sold individually or as a complete unit. **TURBINE** — 9 Stage, Non-Condensing, Automatic Extraction, 600 PSIG, 600° FTT, 150# Extraction, 30# Back Pressure, 3600 RPM, direct connected to **GENERATOR**—2000 KW 3/60/480 Volts complete with Controls. **BOILER** — 4 Drum Bent Tube, 75000 #/hr. 650 PSIG, 650° FTT with Water Walls, Oil Fired complete with Fans and Feed Water Pump. **PRINTS** and Photos available. Write **HEAT & POWER CO., INC., POWER EQUIPMENT DIVISION**, 60 East 42nd St., New York 17, N. Y.

# ELECTRICAL POWER EQUIPMENT

## A. C. MOTORS—3 Ph. 60 Cy.

### SLIP RING

| Qu. | HP | Make | Type | Volts | Speed |
|---|---|---|---|---|---|
| 1 | 1750 | G.E. | M-379BS | 4800/2400 | 1800 |
| 1 | 1500 | G.E. | MT | 6900 | 1187 |
| 1 | 1100 | F.M. RB | SP306S | 4800/2400 | 1800 |
| 1 | 880 | Whse. | CW | 550 | 1775 |
| 1 | 700 | Al. Ch. | D.P. | 2300 | 590 |
| 1 | 600 | Whse. | CW-432D-15 | 440 | 1775 |
| 1 | 500 | Whse. | CW | 550 | 380 |
| 1 | 380 | Cr. Wh. | SIZE-718R | 208/406 | 1743 |
| 1 | 350 | G.E. | IM-17A | 440/2200 | 720 |
| 1 | 350 | Whse. | CW-108BC | | |
| | | | C-15 | 440 | 720 |
| 1 | 250 | G.E. | MT-424Y | 4000 | 257 |
| 1 | 250 | Cr. Wh. | SIZE-290 | 2300 | 350 |
| 1 | 250 | A.C. | | 550 | 600 |
| 1 | 200 | G.E. | IM | 2200 | 580 |
| 2 | 200 | G.E. | IM | 2200 | 435 |
| 2 | 200 | Whse. | CW-880 | 2300 | 1775 |

### SQUIRREL CAGE

| | | | | | |
|---|---|---|---|---|---|
| 1 | 800 | G.E. | KT-573 | 2200 | 1180 |
| 1 | 500 | G.E. | FT-559AY | 2300 | 3600 |
| 1 | 350 | Whse. | CS-1115 | 2300 | 900 |
| 4 | 500 | Whse. | CS-1216 | 2200 | 500 |
| 2 | 450 | Whse. | CS-1420 | 2300/4150 | 354 |
| 2 | 100 | Whse. | CS-7151-810H | | |
| 1 | 300 | Elliott | | 6600/4000 | 3565 |
| 1 | 125 | Allis Ch. | BA-0647 | 440 | 1770 |
| 1 | 440 | G.E. | AW-23F8 | 440 | 1170 |
| 2 | 200 | G.E. | IK | 2200 | 500 |
| 2 | 200/150 | Whse. | KT-537 | 440 | 1800 |
| 1 | 200 | Whse. | CS-9459I | 2300 | 1175/875 |
| 1 | 150 | Whse. | CS-1002 | 2300/600 | 450 |
| 1 | 150 | G.E. | CR | 440 | 580 |
| | | | IK-15A | 2300 | 860 |

### SYNCHRONOUS

| | | | | | |
|---|---|---|---|---|---|
| 1 | 7000 | G.E. | ATI | 2240/6800 | 600 |
| 1 | 4350 | C.W. | 2501-SL | 13800/6900 | 514 |
| 1 | 3500 | G.E. | TS-8487P | 4000/2300/4000 | 360 |
| 2 | 1750 | G.E. | ATI | 2300 | 3600 |
| 1 | 1750 | G.E. | TS | 2300 | 900 |

### M-G SETS—3 PH. 60 CY.

| Qu. | K.W. | Make | RPM | DC Volts | AC Volts |
|---|---|---|---|---|---|
| 2 | 2100/1750 | G.E. | 514 | 250/350 | 2300/4000 |
| 1 | 2000 | G.E. | 514 | 600 | 2300/4000 |
| 1 | 1500 | G.E. | 720 | 600 | 6600/13200 |
| 1 | 1500 | G.E. | 600 | 600 | 2300/4150 |
| 1 | 1000 | G.E. | 900 | 260 | 6600 |
| 2 | 1000 | G.E. | 720 | 600 | 6600/13200 |
| 1 | 750 | G.E. | 720 | 275 | 6600/13200 |
| 1 | 500 | Whse. | 900 | 125/250 | 440 |
| 1 | 350 | G.E. | 900 | 125 | 440/2300/4150 |
| 2 | 300 | G.E. | 1200 | 250 | 2300 |
| 1 | 250 | Whse. | 1200 | 275 | 2300 |
| 1 | 200 | El Mfg | 1200 | 250 | 2300/4600 |
| 1 | 300 | Whse. | 1200 | 600 | 2300 |
| 1 | 200 | Whse. | 900 | 550 | 2300 |
| 1 | 200 | G.E. | 1200 | 250 | 550/3300 |
| 1 | 200 | Cr. Wh. | 1200 | 250 | 440 |
| 1 | 150 | Whse. | 1200 | 275 | 2300 |
| 1 | 100 | G.E. | 1200 | 250 | 4160/2400 |

### TURBO GENERATORS

| Qu. | KW | Make | Desc. |
|---|---|---|---|
| 1 | 7500 | Whse. | 650# condensing, 125# auto extraction, 6900 v. |
| 1 | 5000 | G.E. | 400# surface condenser 2400/4150 volts. |
| 1 | 4000 | G.E. | 400# surface condenser 2400/4150 volts. |

### TRANSFORMERS

| Qu. | KVA | Make | Type | PH. | Voltages |
|---|---|---|---|---|---|
| 3 | 2333 | Whse. | OISC | 3 | 13800x2300 |
| 1 | 1666 | G.E. | PYRANOL | 3 auto | 4000/4300/4400 |
| 3 | 1000 | G.E. | OISC | 3 | 13800x460 |
| 2 | 750 | G.E. | FUH | 1 | 4800x2x2/55 |
| 5 | 550 | KUHL | OISC | 1 | 13800x2000 |
| 1 | 225 | Marcus | Air | 3 auto | 208/220 |
| 3 | 100 | G.E. | OISC | 1 | 22800x2400/4160Y |
| 3 | 100 | Whse. | OISC | 1 | 4600x460/230/115 |

### FREQUENCY CHANGER SETS

| Qu. | KW | Make | Freq. | Voltage |
|---|---|---|---|---|
| 5 | 9750 | G.E. | 60/25/60 | 13200/13200 |
| 1 | 5000 | G.E. | 60/50/60 | 11000/6600 |
| 3 | 3500 | G.E. | 25 cy/62.5 | 2300/2300 |
| 1 | 500 | Al. Ch. | 25/60 | 11000/2300 |
| 1 | 300 | G.E. | 60/3000 | 440/880 |

**COMBINATION MILL DRIVES—**
**D.C. MOTORS WITH M.G. SETS & CONTROLS**
**PACKAGE DRIVES IN STOCK**

1—3250 HP Elliott 300 V. 200/300 RPM DC Motor with 2400 KW GE MG Set. 300 V. DC 2300/4600 V, 450 RPM 3 ph. 60 cy.

1—1375 H.P. G.E., MCF, 415 V. 1300 RPM D.C. motor with 1100 KW G.E. MG Set 415 V DC, 2300/4000 V. 720 RPM 3 ph. 60 cycle.

1—1200 HP G.E. MPC, 600 V, D.C. Motor, 450 RPM, and 1000 KW, G.E. M-G Set, 600 volt DC with 1400 KP, .8 PF, Synch. Motor 13200/6600 volt, 3 ph. 60 cy.

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## BELYEA COMPANY INC.

43 Howell St., Jersey City 6, N. J.
Tel: OLDFIELD 3-3334

# 37 Years Dependable Service

### SLIP RING MOTORS 3-Ph., 60 Cy.

| H.P. | Volts | Make | Speed |
|---|---|---|---|
| 500 | 4000/2300 | G.E. | 600 |
| 450 | 440 | Whse. | 514 |
| 400(2) | 2300 | G.E. | 900 |
| 400 | 4000/2300 | Whse. | 720 |
| 350 | 4000/2300 | G.E. | 720 |
| 300 | 2300 | G.E. | 900 |
| 300 | 440 | G.E. (hoist) | 600 |
| 300 | 440 | Whse. | 3600 |
| 225 | 4000/2300 | G.E. (hoist) | 600 |
| 200 | 2300 | G.E. | 600 |
| 200 | 2200/440 | G.E. | 720 |
| 150 | 220/440 | Whse. | 720 |
| 125 | 2200 | G.E. | 600 |

### AC GENERATORS or SYN. MOTORS, 60 Cy.

| H.P. | Volts | Make | Type | R.P.M. |
|---|---|---|---|---|
| 400 | 2300/440 | G.E. | ATI | 720 |
| 300 | 2300/400 | G.E. | TS | 720 |
| 300 | 2200/440 | G.E. | TS | 1200 |
| 200 | 2300/440 | Whse. | G | 1200 |
| 150 | 440/220 | Whse. | G | 1200 |
| 150 | 440/220 | G.E. | TS | 900 |
| 125 | 440/220 | Whse. | HR | 400 |

### SQUIRREL CAGE MOTORS

| | | | | |
|---|---|---|---|---|
| 500 | 2200/4000 | Elliott | SC | 1800 |
| 400 | 2300 | G.E. | FT | 3600 |
| 350 | 2300/440 | G.E. | IE-K | 1200 |
| 300(2) | 2200 | G.E. | FT | 3600 |
| 300 | 2300/4000 | L. Allis | FS | 1800 |
| 200 | 440/220 | G.E. | KT | 1800 |
| 200 | 2200 | G.E. | KT | 1800 |
| 200 | 2200 | Cent. | TEFC | 3600 |
| 200 | 440/220 | G.E. | KT | 720 |
| 200 | 2200/440 | G.E. | IE-K | 1200 |
| 150 | 440 | Whse. | X-prf. | 3600 |
| 150 | 2200 | Al. Chal. | KT | 720 |
| 150 | 440/220 | G.E. | TEFC | 720 |
| 150 | 2200/440 | G.E. | AR | 1800 |
| 150 | 2200/440 | | KT | 600 |
| 150 | 2200/440 | G.E. | FT | 1200 |
| 125(2) | 2200/440 | Whse. | X-proof | 720 |
| 125 | 2200/440 | G.E. | K | 600 |
| 100(2) | 4000/2300 | L. Allis | OX | 1200 |
| 100 | 2300 | Cont'l. | TEFC | 3600 |
| 75(2) | 440 | Wagner | TEFC | 1800 |

### CIRCUIT BREAKERS, 3 Pole

1—6000 Amp., Whse., 600 V., Air, New
1—2000 Amp., R-Smith, 600 V., Air, New
4—1600 Amp., DA-50, Whse., 600 V., Air
6— 600 Amp., R. Smith, 7.5 KV, Sol. oper.
1— 400 Amp., R. Smith, 7.5 KV, outdoor, New

### D. C. MOTORS

| H.P. | Volts | Make | Type | Speed |
|---|---|---|---|---|
| 200 | 230 | Cr. Wh. | CMC | 1200 |
| 150 | 230 | El. Dyn. | B/brg. | 600 |
| 125 | 230 | G.E. | CD | 350 |

### MOTOR GENERATOR SETS

| KW | Make | Input V., AC | Motor / Type | Output V., DC |
|---|---|---|---|---|
| 250 | Whse. | 440 | Syn. | 250 |
| 125 | G.E. | 440/220 | Sq. Ca. | 125 |
| 125 | G.E. | 440 | Sq. Ca. | 250/125 |
| 100 | G.E. | 2200/440 | Syn. | 250 |
| 75 | Cr. Wh. | 440/220 | Sq. Ca. | 240/120 |
| 65 | G.E. | 2200/440 | Sq.Ca. | 250 |

### TRANSFORMERS 60 Cy.

1—500 kva, Al. Ch., 2400/4160Y—400 volts, 3 ph.
3—500 kva, G.E., 13,800—2300 V.
3—333 kva, G.E., 13,800—2300 V.
3—833 kva, G.E., 2400-240/480 V.
9—300 kva, G.E., 4150—240 V., 3 ph., Pyr.
1—200 kva, Al. Ch. 6900—220 V., 3 ph.
3—200 kva, Whse., 4600/2300—230/115 V.
1—200 kva, G.E., 2400—120/240 V., Pyr.
3—200 kva, Mol. 13,800—2300 V.
3—150 kva, Al. Ch. 2400—220 V.
3—150 kva, Al. Ch. 440-220 V., dry New
3—150 kva, G.E. 13,800—2300 V.
3—100 kva, Whse. 4800/2400-240/480 V., Dry
3—100 kva, G.E., 2400—120/240 V., Pyr.

### GASOLINE—ENGINE GENERATOR SETS

1—94 kva 1200 R 220 V 3 ph. Buda, 6 cyl. SLIGHTLY USED
2—85 kva 900 R 220 V 3 ph. conn. LeRoi, 6 cyl.

*only partial listing*

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GENERAL ELECTRIC 6-section cubicle, with (5) type FKR-225-150, 6-P.B.T., 600 amps., 15-KV Mag. Draw-out O.C.B.'s, complete with metering equipment. 150-M.V.A.

GENERAL ELECTRIC 7-section, OUTDOOR Cubicle with (5) AM-5-100-4Z, 1200 amps., 5-KV mag. Draw-out Air Breakers, with all metering, batteries, charger, etc., 10-M.V.A.

(1) 400 AMPS. 73-KV WHSE. OUTDOOR 3-pole Mag. O.C.B. type G-11-500-M.V.A.

*SAVE $30,000. ON THIS PACKAGE*

(1) 600 AMPS. G.T. type F.L.O. 14.4-4-250, 3-pole Mag. OUTDOOR O.C.B., 250-M.V.A.

(1) 600 AMPS. AL. CH. type FZO-50-34X, OUTDOOR 3-pole Mag. O.C.B. 34.5-KV, 250-M.V.A.

(1) WHSE. OUTDOOR 3-section cubicle with (2) 600 AMPS., 3-pole Mag. O.C.B.'s type F-100, 15-KV, 100-M.V.A. with complete metering.

*WEST COAST BUYERS—NOTE—Stored in Seattle—Priced, Right.*

(6) G.E. 2500-KVA Transformers, new 1945, Prim. 14,490/13,110 Sec. 2300/4000-Y. SAVE 50%

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Express Type, 3-drum, with integral superheater separately fired.
Includes boiler, superheater, economizer, 7 fuel oil burners, soot blowers.
Pressure 634 psi, temp 850° F.
Furnace Vol: boiler 310 cu. ft., superh. 247 cu. ft.

### 60,000 Lbs.

10 Babcock Wilcox
3 Foster Wheeler
"D" Type, 2-drum, with integral superheater fired between boiler tube bank.
Includes boiler, superheater, economizer, 3 fuel oil burners, soot blowers.
Pressure 435 psi, temp 750°F.
Furnace Vol: 330 Cu. Ft.

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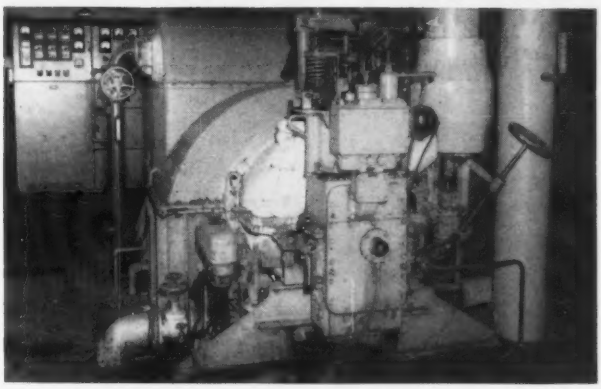

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### 1500 HP D.C. MOTORS

1500 HP—525 volts D.C.—600 R.P.M.—NEW—2-bearing continuous duty motors—manufactured by Westinghouse. In original crates. From Navy Destroyer Escort. SPECIFICATIONS: 2-bearing 1500 HP—525 volts DC—2270 amps—600 RPM—ambient temperature 40C—class B insulation—2-bearing pedestal sleeve type—shunt wound—efficiency 94.23%. ONLY 6 AVAILABLE—BUY NOW AND SAVE. Suitable for steel mill drive—offshore oil rigs—rolling mill drive—dredge pump applications.

### 1200 KW GENERATORS

(2) Equal to new—manufactured by Allis-Chalmers. 1200 KW—525 volts D.C.—2290 amps 750 RPM—cooling self-ventilated—totally enclosed—separate excitation—continuous duty—class B insulation—mfg type M.H.C.—frog leg armature.

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ELGIN 5-5050 LEXINGTON 9-1900

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**STEAM BOILERS**
2—18000 lbs./Hr. Heine 175 psi, straight tube oil fired, 1920
3—21000 lbs./Hr. Combustion Engr. 200 psi, Stoker fired, 1938
1—30,000 lbs./Hr. Combustion Engr. 450 psi, 825° stoker fired, 1950

**SURFACE CONDENSER**
1—2500 Sq. Ft Westinghouse, 2 Pass, with aux., 1950

**DIRECT CURRENT GENERATOR**
1—250 KW, Westinghouse, 250V, 720 RPM, 1950

**MOTOR GENERATOR SET**
1—25 KW, Westinghouse, 250V DC, 208/120V AC, 1800 RPM, 1950

**WATER PUMPS**
1—14000 GPM @, 185/370' Hd. De Laval Centrifugal, 690 RPM, 1920
1—20800 GPM, @, 185/370' Hd. De Laval Centrifugal, 720 RPM, 1949
1—24500 GPM @, 185/370' Hd. Worthington Centrifugal, 950 RPM, 1954

**STEAM TURBINES**
1—1800 HP, De Laval Condensing, 165 lbs. psi 3600/690 RPM, 1920
1—2500 HP, De Laval Condensing, 400 lbs. psi 3600/720 RPM, 1949
1—3200 HP, Worthington Condensing, 175 lbs. psi 3600/950 RPM, 1954

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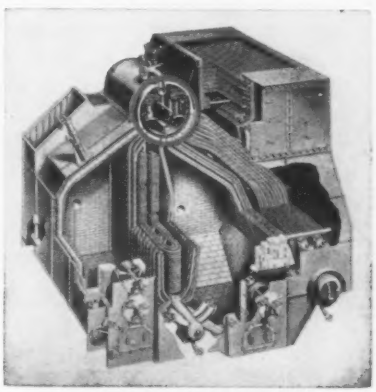
Cleveland 14, Ohio Main 1-9514



**16 NEW UNASSEMBLED BOILERS.**

B&W, Combustion Engineering, Foster Wheeler. Steel encased. 2 Drum Water Tube with Water Walls, Superheater, Economizer, Soot Blowers, Oil Burners. Complete.

| # Steam/hr | PSIG | FTT |
|---|---|---|
| 153,600 | 565 | 850 |
| 122,500 | 565 | 850 |
| 60,000 | 435 | 750 |
| 44,500 | 450 | 735 |
| 35,000 | 285 | 577 |

**PRINTS** and Photos available. Write **HEAT & POWER CO., INC., POWER EQUIPMENT DIVISION**, 60 East 42nd St., New York 17, N. Y.

## DIESEL ENGINES — POWER MACHINERY

100 KW to 1500 KW
Diesel Generator Sets • Stationary • Portable • Mobile Motors and Generators

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**Thousands of new and "Certified Rebuilt" Motors & Generators in stock—up to 1000 H.P. OUR 52nd YEAR**

## A. C. MOTORS—60 CYCLE

| HP | Mfr. | Type | Volts | Speed |
|---|---|---|---|---|
| 800 | Whse. (2) | Sq. Cage | 2300 | 1800 |
| 700 | Whse. | Slipring | 2300/4000 | 1200 |
| 600 | Elliott (2) | Sq. Cage | 2200 | 900 |
| 500 | G.E. | Slipring | 2200/440 | 600 |
| 500 | Whse. | Slipring | 2200 | 450 |
| 400 | Whse. (2) | Synch. | 2200 | 1800 |
| 400 | Whse. | Sq. Cage | 2200 | 514 |
| 400 | Marathon (2) | Sq. Cage | 2200 | 3600 |
| 400 | Whse. | Sq. Cage | 2300 | 900 |
| 400 | G.E. (2) | Slipring | 440 | 900 |
| 400 | G.E. | Slipring | 2300 | 514 |
| 350 | G.E. | Sq. Cage | 2200 | 1800 |
| 350 | G.E. | Slipring | 440 | 1200 |
| 350 | Allis Ch | Slipring | 2200/4000 | 600 |
| 300 | El. Machy (2) | Synch. | 2200/440 | 720 |
| 300 | G.E. | Slipring | 2200/440 | 600 |
| 300 | G.E. (2) | Synch. | 2200/440 | 360 |
| 300 | Whse. | Synch. | 440 | 1200 |
| 250 | G.E. | Sq. Cage | 2200/440 | 1200 |
| 250 | Gen. Elec. | Sq. Cage | 440 | 3600 |
| 250 | G.E. | Slipring | 220/440 | 720 |
| 250 | G.E. | Sq. Cage | 2200 | 1800 |
| 225 | G.E. | Synch. | 220/440 | 900 |
| 200 | L.A. TEFC | Sq. Cage | 440 | 1200 |
| 200 | G.E. | Slipring | 2200 | 900 |
| 200 | Reliance b.b. | Sq. Cage | 220/440 | 1800 |
| 200 | Allis Ch. | Slipring | 440 | 450 |
| 200 | Allis Ch. | Slipring | 2200/440 | 720 |
| 200 | Whse. | Sq. Cage | 2200/440 | 900 |
| 175 | G.E. (2) | Synch. | 220/440 | 720 |
| 150 | Rel. TEFC | Sq. Cage | 220/440 | 900 |
| 150 | G.E. (4) | Slipring | 2200/440 | 600 |
| 150 | Cr. Wheeler | Sq. Cage | 220/440 | 450 |
| 150 | G.E. (2) | Sq. Cage | 2200/440 | 1800 |
| 150 | Whse. | Slipring | 220/440 | 1200 |
| 125 | G.E. TEFC | Sq. Cage | 2200 | 3600 |
| 125 | Ideal | Slipring | 4000/2200 | 900 |
| 125 | Al. Ch. TEFC | Sq. Cage | 220/440 | 600 |
| 100 | Whse. TEFC | Sq. Cage | 220/440 | 900 |
| 100 | Smith b.b. (6) | Sq. Cage | 220/440 | 1800 |

## D. C. GENERATORS

| KW | Mfr. | Type | Volts | Speed |
|---|---|---|---|---|
| 200 | G.E. b.b. | CD | 250 | 1800 |
| 150 | Whse. | SK-184 | 250 | 1150 |
| 150 | Cr. Wh. | CCD | 250 | 650 |
| 125 | Gen. Elec. | CD | 250 | 1150 |
| 100 | Allis Ch. | E | 125 | 1200 |
| 100 | Reliance | 651-T | 600 | 1200 |
| 75 | Gen. Elec. | CD-123 | 125/250 | 1200 |
| 60 | Allis Ch. (2) | E-146 | 250 | 1500 |
| 60 | Ideal | D | 125 | 1150 |
| 25 | Whse. | SK-103 | 250 | 1750 |

## D. C. MOTORS

| HP | Mfr. | Type | Volts | Speed |
|---|---|---|---|---|
| 200 | G.E. b.b. | CY-200 | 230 | 1750 |
| 170 | Cr. Wh. | 151-H | 230 | 580 |
| 150 | Whse. | SK-184 | 230 | 850 |
| 150 | Whse. | SK-210 | 230 | 320/1000 |
| 125 | G.E. | CD-173 | 230 | 575/1150 |
| 100 | Reliance | 651-T | 550 | 1000/1800 |
| 100 | Elliott b.b. T.E. | J11-FF | 230 | 1150 |
| 75 | Whse. (4) | SK-163 | 230 | 500/1500 |
| 60 | G.E. TEFC b.b. | CD-135 | 230 | 1150 |
| 50 | Century | DX-514 | 230 | 1150/1750 |
| 50 | Gen. Elec. | CD-95 | 230 | 1800 |
| 50 | G.E. | CD-125 | 230 | 400/1200 |
| 50 | G.E. | RF-16 | 230 | 250/1000 |
| 40 | G.E. (2) | CD-93 | 230 | 1750 |
| 25 | Whse. (2) | SK-153 | 230 | 300/1200 |

## MOTOR-GENERATOR SETS

| KW | Mfr. | Input V | Output V |
|---|---|---|---|
| 600 | Allis Ch. | 440 AC | 250 DC |
| 200 | Gen. Elec.* | 220/440 AC | 125 DC |
| 200 | G.E. | 2200/440 AC | 600 DC |
| 175 | Gen. Elec. | 220/440 AC | 250 DC |
| 125 | Gen. Elec.* | 2300/4000 AC | 250 DC |
| 100 | Gen. Elec.*(2) | 220/440 AC | 250 DC |
| 75 | Gen. Elec. | 220/440 AC | 250 DC |
| 75 | G.E. | 220/440 AC | 125 DC |
| 60 | Allis Ch. | 220/440 AC | 250 DC |
| 50 | Cr. Wh. b.b. (2) | 220/440 AC | 250 DC |

**Arthur Wagner Co.**

Certified

MO nroe 6-7409

1435 W RANDOLPH ST

CHICAGO 7, ILLINOIS

# BARGAINS NEW CONDENSER

## 11000 SQ. FT. UNITS

5 New Worthington Surface Condensers—11000 sq. ft. each—single pass—Monel water boxes—Cupro-Nickel tubes & tube sheets. Tubes ⅝ O.D. CAPACITY lbs/hr—70,000; circulating water 14180; circulating water connection 30"; operating weight 86,000 lbs; overall length approx. 21'; width & height 9'4". Built for U.S. Navy. Designed for low head room.

## 8900 SQ. FT. UNITS

1 New unit by C. H. Wheeler. Test pressure shell 30 lbs; water box 30 lbs.—single pass Turbine steam exhaust inlet 6' 1¾" x 10' 2". Overall width 12' 2¼"; overall length 14' 10¾"; overall height 5'7". Water inlet 36" x 30" outlet. Monel heads and water boxes; Cupro-Nickel tubes. Built for U.S. Navy of very best materials.

## 1135 SQ. FT. UNITS

2 New Units by C. H. Wheeler. 2-pass—shell 30 PSI—tubes, chest 30 PSI; DIMENSIONS 42" diam.—12' long. 24" exhaust steam inlet—water box inlet & outlet 10". 9300 lbs./hr steam capacity; 1175 GPM circulating water. Complete with twin air ejectors type 4H Wheeler with inner cooler. Built originally for Navy.

## 580 SQ. FT. UNITS

6 New units—Capacity: 4300 lbs/hr on 28.5 vacuum. 8" water inlet & outlet—18" steam inlet. 2 pass— complete with air ejectors.

## 3 LIBERTY SHIP TYPE UNITS

2700 Sq. Ft.—2-pass type.

OTHER SIZES IN STOCK FOR IMMEDIATE DELIVERY

## NEW CIRCULATING PUMPS

1 only—vertical circulating pump—all-bronze propeller type—geared turbo driven—840 RPM—26500 GPM at 25' head. W.P. turbine, Westinghouse, 575 lbs—0°F superheat. Pump—Warren type 25 VP.

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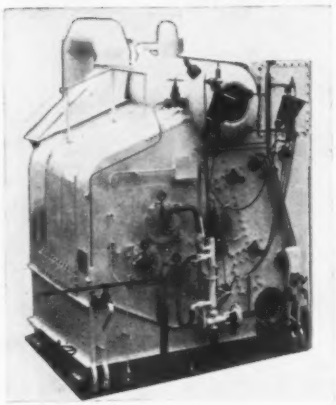
BALTIMORE 2, MD. ELgin 5-5050

# HIGH PRESSURE STEAM BOILERS ASSEMBLED



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Combustion Engr. Co. 2 drum packaged water tube type, steel encased, oil fired, superheater—economizer — soot blowers — valves — gauges. Boiler shipped as one integral unit. Immediately available.

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300 KW G.E. Non-C. Turbo. Generator
3/60/480 V 150# 5-10#-BP.
3600 RPM

45000# Combustion Engineering BOILER
450# 750° TT oil fired

500 KVA 3 ph 60 cy 4150 V G.E.
FEEDER VOLTAGE REGULATOR
step type MLT-32—New

**BREW, WOLTMAN & CO., INC.**
50 Church St., New York 7, N. Y.

# TRANSFORMERS

1—300 KVA, 3/60/4160-240 Wagner, ITE type HPE Unit Substation, Outdoor.
2—250 KVA, 1/60/2400-240/480 Moloney OISC, type YC, with taps
1—225 KVA 3/60/440-208Y/120, Moloney Dry
1—250 KVA, 4—150 KVA, and 2—100 KVA 1/60/4160-240/120 Whse. Inerteen with taps
1—200 KVA 3/60/4160-240 Wagner, ITE type RPB Unit Substation, Outdoor.
3—15 KVA, 1/60/240-480/120-240 Sorgel Dry

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2—1500 KVA Moloney all steel, 3 phase, 60 cycle, 33,000 to 2300/460, type TC-R, 55°C, impedance 6.75%, five 5% taps, external steel tubes for oil cooling, expansion tank on each transformer.

3—500 KVA Westinghouse 1/60/33000 to 2300
3—500 KVA GE, 1/60/6600 to 2300
3—250 KVA Standard 1/60/33000 to 6900/11950Y.
3—75 KVA Gregory 1/60/4000 to 2300

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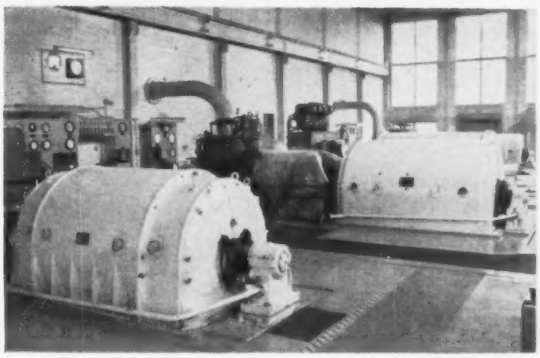
**650 lb., 725 DEG TURBO GENERATORS — Still on Original Foundations As Shown in Photo Below — All Westinghouse, 3600 RPM, 80% P.F., 6900 V, 3/60.**



1—9375 KVA, 7500 KW, 125 P.S.I.G. auto extraction, surface condenser, installed in 1937.
1—9375 KVA, 7500 KW, non-condensing, 125# B.P., installed 1930.
1—6250 KVA, 5000 KW, Condensing, with surface condenser, installed 1942.

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**The following eqjuipment — *now in operation* — and available for purchase**

One (1) Worthington Vertical Circulating Water Pump, 37,200 gpm, 57 ft TDR with 700 hp, 327 rpm, 2300 volt G.E. Motor. Installed late 1947.

One (1) ITE Unit Substation assembly, outdoor type, 400 kva, 2400-480 volt oil cooled transformer; switchgear four frame mounting with seven type KA breakers. Installed late 1947.

One (1) Marley Cooling Tower, induced draft, #7-30 Double Flow, 14 cell, 63 ft x 211 ft x 25 ft high, with seven (7) three bladed adjustable pitch stainless steel clad fans, seven 60 hp, 1800 rpm, 440 volt motors and accessories. Tower designed for 42,200 gpm, 316 million Btu/hr duty, 105 F water to tower, 90 F water from tower, 76 F wet bulb. Installed December 1947.

One (1) Marley Cooling Tower, induced draft, #9-2431 Double Flow, 9 cell, 63 ft x 217 ft x 39 ft high, with nine (9) aluminum alloy fans, nine 60 hp, 1800 rpm, 440 volt motors, and accessories. Tower designed for 61,300 gpm, 553,500,000 Btu/hr, 108 F water to tower, 90 F water from tower, 76 F wet bulb. Installed October 1950.

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**Attn: E. V. BROOME** **P.O. BOX 970, FT. WORTH, TEXAS**

**1875 KVA POWER PLANT. STILL INSTALLED.** Will be sold as complete unit or piece by piece. **TURBINE**—400 PSIG, 700°FTT with Surface Condenser and Pumps, direct connected to **GENERATOR** — 1875 KVA, .8PF, 3/60/2300/3600 RPM, complete with Controls. **BOILER**—25,000 #/hr, 450 PSIG, 738° FTT, Stoker Fired with Superheater, Fans, Feed Pumps. **AUXILIARIES**—Deaerating Heater, Coal Crusher, Elevator and Conveyors. **CRANE**—25 Ton, 36' Span. **PRINTS** and Photos available. Write **HEAT & POWER CO., INC., POWER EQUIPMENT DIVISION**, 60 E. 42nd St., New York 17, N. Y.

**COAL PULVERIZERS**
B & W type E, size 32, 75 HP motor.
RAYMOND #15 Super Mill, 66" dia., 6 roll, 200 HP.
PENNA. CRUSHER, Ring Granulator, 40 HP.
**PERRY EQUIPMENT CORP.**
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Complete Switchboard Design and Construction
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DIESEL and GAS GENERATOR UNITS
USED & REBUILT EQUIPMENT
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**WORLD'S BEST REBUILTS**

| | | |
|---|---|---|
| 100 CFM | 125 psi | 6x7 Ing. |
| 138 CFM | 100 psi | 7x7 Ing. ES-1 |
| 191 CFM | 350 psi | 9-4x9 Ing. ES-2 |
| 238 CFM | 100 psi | 9x9 Ing. ES |
| 268 CFM | 500 psi | 10-4½x10 Ing. or Worth. |
| 465 CFM | 100 psi | 12x11 Ing. |
| 496 CFM | Vacuum | 14x7 Chicago TVB |
| 502 CFM | 125 psi | 12x13 Worth. HB. |
| 585 CFM | 100 psi | 15-9¼x12 Ing. XRE 3-60-4160 |
| 590 CFM | 100 psi | 13½-8x8 Penn DE2 3-60-220 |
| 628 CFM | 100 psi | 14x13 Worth HB |
| 676 CFM | 100 psi | 15-9¼x12 Ing. XRB—Worth. |
| 870 CFM | 125 psi | 17-10½x12 Ing. XRE 3-60-220 |
| 1007 CFM | 100 psi | 19-11x12 Chic. OCB |
| 1008 CFM | 125 psi | 16/10½x8½ Worth YC-2 |
| 3864 CFM | 125 psi | 33-20½x24 IR-PRE, 700 H.P. 3-60-2300—see running |

PORTABLES—55-60 CFM Rotary or Reciprocating
**AMERICAN AIR COMPRESSOR CORP.**
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"For BIGGER SAVINGS and BETTER SERVICE, Get Our BARGAIN PRICES on Guaranteed New and Rebuilt Motors"

### SQUIRREL CAGE MOTORS
NEW AND GUARANTEED REBUILT

| HP | Make | Type | Speed |
|---|---|---|---|
| 400 | West. S.B. Drip | CSP-681S | 1800 |
| 400 | West. S.B. Open | CS | 900 |
| 380 | A.C. S.S. Drip | ARWW-626 | 3600 |
| 300 | G.E. S.B. Open | IK | 1800 |
| 300 | F.M. B.B. Open | H | 1800 |
| 300 | G.E. S.B. Open | IK | 900 |
| 300 | G.E. S.B. Open | IK | 720 |
| 300 | West. S.B. Open | CS-1002 | 600 |
| 250 | G.E. S.B. Open | KT | 1800 |
| 250 | F.M. B.B. Open | H | 1800 |
| 250 | G.E. S.B. Open 2200 V | IK-16 | 1200 |
| 250 | G.E. S.B. Open | IK | 1200 |
| 250 | G.E. S.B. Open | IK | 900 |
| 250 | G.E. S.B. Open | IK | 720 |
| 200 | G.E. S.B. Drip | K-6326 | 3600 |
| 200 | F.M. B.B. Open | H-207 | 1800 |
| 200 | G.E. TEBB | K | 1800 |
| 200 | Cont. T.E.F.C. B.B. | NP-686C | 1800 |
| 200 | G.E. S.B. Open | IK-15 | 1200 |
| 200 | G.E. S.B. Open | IK-156 | 1200 |
| 200 | G.E. S.B. Open 2200 V | IK | 1200 |
| 200 | G.E. S.B. Open | IK | 900 |
| 200 | English B.B. Open | P-125.5 | 720 |
| 150 | G.E. TEFCBB | K-6328 | 3600 |
| 150 | G.E. TEFCB XP | K | 3600 |
| 150 | G.E. TEBB | K | 1800 |
| 150 | West. S.S.B. Open | CS-773C | 1800 |
| 150 | West. S.B. Open 2200 V | CS | 1800 |
| 150 | G.E. S.B. Open | IK | 1800 |
| 150 | West. S.S.B. Open | CS-761C | 1800 |
| 150 | West. B.B. Open | CS-771C | 1800 |
| 150 | G.E. B.B. Open | KT | 1200 |
| 150 | Cont. T.E.F.C. B.B. New | | 900 |
| 150 | G.E. S.B. Open | IK | 720 |
| 150 | West. S.B. Open | CS-878A | 720 |
| 125 | G.E. TEFCBB | K | 3600 |
| 125 | West. S.S.B. Open New | CS-607 | 1800 |
| 125 | G.E. S.B. Drip | K-505 | 1800 |
| 125 | G.E. S.B. Open | IK | 1800 |
| 125 | West. S.S.B. Open | CS | 1800 |
| 125 | A.C. B.B. Open | AR-505 | 1800 |
| 125 | El. Dyn. B.B. Drip | KNX-222 | 1800 |
| 125 | G.E. S.B. Open | KT-553 | 1200 |
| 125 | G.E. S.B. Open | IK | 1200 |
| 125 | G.E. S.B. Open | IK | 900 |
| 125 | G.E. S.B. Open | IK | 720 |
| 125 | G.E. S.B. Open | IK | 600 |
| 100 | A.C. B.B. Open | AR | 3600 |
| 100 | El. Dyn. T.E.F.C.B.B. XP | KNX-223 | 1800 |
| 100 | G.E. S.B. Open | KT-343 | 1800 |
| 100 | Master, T.E.F.C.B.B. | PA-505 | 1800 |
| 100 | A.C. S.B. Open 2200 V | ARX | 1800 |
| 100 | L.A. T.E.F.C.B.B. | JX-113 | 1800 |
| 100 | West. S.S.B. Splash | CS-770.3 | 1200 |
| 100 | G.E. B.B. Open | K-504 | 1800 |
| 100 | G.E. S.B. Open | KT-347 | 1200 |
| 100 | Reliance T.E.F.C.B.B. | AA-5085 | 1200 |
| 100 | West S.B. Open 2200V | CS-774C | 900 |
| 100 | G.E. S.B. Open | IK | 900 |
| 75 | G.E. B.B. Drip. | K-444 | 3600 |
| 75 | West. B.B. Splash. 440V | CS-445 | 3600 |



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### TURBO GENERATORS — CONDENSING

1—G.E. Co., 5,000 KW Curtis steam turbine, condensing 5 stage, form J, 175 lb. steam pressure, connected to: 5,000 KW A.C. generator, type ATB-2-6250M-3600, form HT, 1,569 amps., 2,300 volts, 3 phase, 60 cycle, 3,600 RPM, 80% power factor unit complete with control panels, valves, and steam piping.

1—W.E. & M. Co. 12,500 KVA, steam turbine, condensing, 1,800 RPM, 175 lb. steam pressure, connected to: 12,500 KVA, A.C. Generator, 11,000 volt, 3 phase, 60 cycles, 656 amps., per terminal, 1,800 RPM direct connected to: 100 KW D.C. Generator, 125 volt, 800 amps., 1,800 RPM.

1—W.E. & M. Co. 3,750 KVA, steam turbine, condensing 3,600 RPM 175 lb. steam pressure, connected to, 3,750 KVA A.C. Generator, 2,400 volts, 3 phase, 60 cycle, 904 amps., per terminal, 3,600 RPM, connected to: 25 KW, D.C. Generator, 125 volts, 160 amps., 360 RPM.

### BOILERS

5—B.W. Boilers—512 H.P.—180 lb. W.S.P.
3—Edgemoor—500 H.P.—180 lb. W.S.P.
All related equipment—soot blowers, forced draft fans, feed water heaters, water filters, etc.

### COMPLETE COAL HANDLING EQUIPMENT

Crushers, pulverizers, tipples, 24" belt conveyors, hoppers, bucket conveyors, weigh systems—drag line—motors, speed reducer, etc.

### TRANSFORMERS

3—W.E.M. Single phase, primary volts 33000/46,200—11,000 volts—4167 KVA.

### ELECTRICAL EQUIPMENT

M G Sets—Disconnect switches—Circuit Breakers—Controls, etc.

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Air Compressers—motors from 1 H.P. to 500. All sizes of pumps—valves—Steel and cast iron pipe from 1"-24". Steel and wooden tanks. Water screens—water sprays. 15 Ton Northern Bridge crane—26.6" span, etc.

*Inspection Invited*

**Job Site — Hazard, Kentucky**

**Reply to:**

**PLATNICK BROTHERS**
**BLUEFIELD, VIRGINIA**
**Phone: FAirfax 6-1115**



## SYNCHRONOUS MOTORS
### 3 Ph. 60 Cy.

| Qu. | H.P. | Mfg. | Volts | RPM | Pr |
|---|---|---|---|---|---|
| 1 | 1250 | Fbl | 13,200 | 720 | $7,500 |
| 3 | 700 | Whse. | 2300 | 1200 | 5,000 |
| *2 | 350 | GE TS7653 | 2300 | 900 | 1,900 |
| 1 | 300 | Whse. | 2200 | 1200 | 1,500 |
| 1 | 250 | GT ATI | 2200 | 1200 | 1,250 |
| *2 | 135 | GE TS863Z | 4000 | 1200 | 1,000 |
| 1 | 125 | El. Mfg. B.Brg. | 4800 | 900 | 1,000 |

*Above Less Exciters

## TEFC SQUIRREL CAGE MOTORS
### 3/60/B.BRG.

| | | | | | |
|---|---|---|---|---|---|
| 20 | 150 | Cont'l NF743X | 440 | 900 | $1,500 |
| 4 | 75 | Cont'l AF109X | 220 | 900 | 1,000 |
| 1 | 75 | AC ARZ823PS | 2200 | 3500 | 500 |

## DC MOTORS & GENERATORS

| | | | | | |
|---|---|---|---|---|---|
| 28 | 1500 | Whse (New) | 525 | 600 | $5,000 |
| 4 | 1200KW | AC | 525 | 720 | 5,000 |
| 1 | 710KW | GE | 545 | 1600 | 1,250 |
| 1 | 500KW | Whse. | 120/240 | 1200 | 2,500 |
| 3 | 300KW | GE | 260 | 1200 | 1,000 |
| 2 | 100 | Diehl B.Brg. | 230 | 1750 | 1,000 |
| 10 | 65 | Burke B.Brg. (New) | 230 | 1750 | 900 |
| 20 | 50 | Whse. CK9 | 230 | 600 | 400 |
| 50 | 30 | Star B.Brg. (New) | 230 | 2200 | 300 |
| 50 | 12.5 | GE COM1826AE (New) | 230 | 600 | 200 |

## MG SETS—3 Ph. 60 Cy.

| | | | | | |
|---|---|---|---|---|---|
| 2 | 125KW | Whse. B.Brg (4) | AC 440V DC 120 | 1200 | $1,750 |
| 1 | 100KW | Burke B.Brg. | AC 2300 DC 230 | 1200 | 1,250 |

**MOST EVERYTHING IN ELECTRICAL EQUIPMENT**

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ULster 5-8643



600 CFM Diesel Portable Air Compressors
36"x48" Jaw Crusher—Excellent condition
150 HP, 870 RPM, Motor with controls
10' Electric Power Shear—good buy
1000 & 300 KW Slow Speed Diesel Sets
350 HP, 2300 V. Mtrs. 1200/1800/3600 RPM
150 HP, 125# Erie City Boiler
1400 HP, 450 lb. Pressure WT Boiler
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## 2 OIL BURNING BABCOCK & WILCOX WATER TUBE BOILERS

***Designed for T2-SE-A2***

***Now being removed at Philadelphia, Pa., from the S.S. Mission San Francisco.***

Complete with deaerating feed heaters, Coffin feed pumps, oil pumps, 1st, 2nd & 3rd stage heaters. Evaporation: normal 43,000 lbs.; max. 60,000 lbs. Designed boiler pressure 700 P.S.I. Final steam temp. at superheater outlet 825° normal. Superheat safety valve setting 624 P.S.I. Boiler heating surface including water wall 6350 sq. ft. Total water heating surface 8030 sq. ft. Economizer heating surface 1680 sq. ft. Operating pressure superheater outlet 600 P.S.I. Furnace volume 573 cu ft. Evaporation rate from and at 212 F lbs/hr/sq ft of total boiler heating surface: Normal 8.33—max. 11.74. Water wall heating surface 118 sq ft. Feed water temp 240 F. Immediate delivery. Presently on barge at Philadelphia. Dimensions: 19'8" high over drum flange: 14' 9-5/16" over casing plate; 16' wide over drum.

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**313 E. BALTIMORE STREET**
**BALTIMORE 2, MD. ELgin 5-5050**



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### 15 NEW TURBINES

**4 horizontal, 11 vertical, Westinghouse** Driving forced draft blowers—capacities ranging from 39000 to 56000 CFM and 16" to 24" pressure. Steam pressures 360 to 575#, back pressure 10#.

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*Also*—1—250 KW GE turbo generator unit, 3 phase, 60 cycle, 440 volt. Used one year.

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**2457 WOODWARD AVE.**
**706 DONOVAN BLDG.**
**DETROIT 1, MICH.**



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**400 KW General Motors Quad portable diesel generator. 650 HP. Skid mounted, radiator cooled. Westinghouse 3/60/2300 generator, complete, used 60 days.**

450 HP Fairbanks Morse Model 32E14, 375 KVA. 3/60/2400 volts. With complete auxiliaries. New in 1944.

*Condition is first class. Priced attractively.*

*Other sizes available. Also Construction and Railway equipment.*

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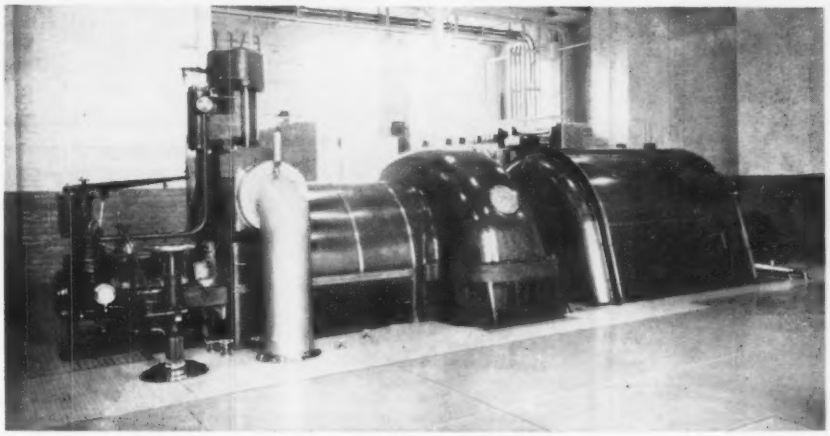
**611 Olive St. St. Louis 1, Mo.**
**CHestnut 1-4474**

# BARGAIN OFFERING

## 6250 KVA—5000 KW, 80% P.F. TURBINE GENERATOR
## 400 PSIG, 700°FTT 3 PHASE 60 CYCLE 2400/4160 VOLTS



(Actual Photograph Above)

5000 KW, 3600 RPM General Electric condensing turbine generator unit, complete installation with surface condenser, auxiliaries and direct connected exciter. Excellent condition.

**UTILITIES MACHINERY CORPORATION**

**1965 EAST SIXTH STREET TELEPHONES: CH 1-0210 & CH 1-4070 CLEVELAND 14, OHIO**

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**PBY Amphibian Aircraft** . . . Only 1400 hours total time completely overhauled and converted to 2 crew handling in 1956. Used almost exclusively on aerial survey work since new, cargo door and floor • Auxiliary power unit • janitrol heater • extremely light weight • excellent condition.

**Royal Gull Amphibian** . . . The world's most economical and versatile "Executive" amphibian • used exclusively as a demonstrator and executive charter ship • only 400 hours since manufacture • new custom exterior paint and customized interior. Available for immediate sale or lease attractive terms.

**DeHavilland Beaver** . . . Top condition throughout • used solely as an ambulance ship since new • zero time—Pratt & Whitney overhauled engine, new C. of A. Excellent radio and instrumentation • complete with Federal wheel/skiis and Edo floats. Your inquiries are invited.

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**TIMMINS AVIATION LIMITED**
**MONTREAL AIRPORT, CANADA**

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## BOILERS

2—B & W 329 hp, 160 psi
1—90,000# B & W Stirling 450 psi
2—B & W sect. header 750 hp 450 psi
2—B & W sect header 800 hp 250 psi
2—Union Iron Works 40,000#, 250 psi
1—Union Iron Works 120,000#, 250 psi
1—Riley 40,000# 280 psi
1—Vogt 40,000# 350 psi

## BOILERS WANTED

B & W sect. header Boilers
1—100,000# at 600# psi Boiler
High capacity and high pressure boilers

**MIDWEST BOILER & TURBINE CO.**
**616 Vaughn Avenue Dyersburg, Tenn.**
**ATwater 5-4396**

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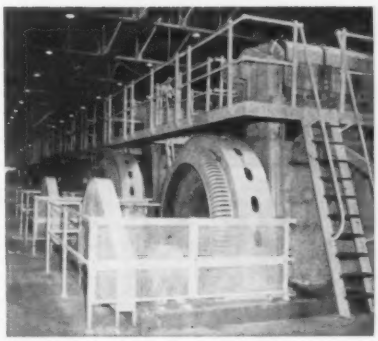

**13,750 KVA POWER PLANT. STILL INSTALLED.** Will be sold as complete unit or piece by piece. Consists of (11) 1250 KVA Rathbun-Jones Natural Gas Generator Sets. **ENGINES**—1430 HP, 8 Cylinder, 4 Cycle, 300 RPM, direct connected to **GENERATORS**—1250 KVA, .8 PF, 3/60/2400-4160. Complete with Switchgear. Can be seen in operation on foundations. **PRINTS** and Photos available. Write **HEAT & POWER CO., INC., POWER EQUIPMENT DIVISION,** 60 E. 42nd St., New York 17, N. Y.

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**New and Used Equipment Available for**
**POWER PLANTS, SUBSTATIONS, TRANSMISSION LINES AND CONSTRUCTION**
*Send for new list*
**EBASCO SERVICES INCORPORATED**
APPARATUS EXCHANGE Two Rector St., New York 6, N. Y.

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## BOILER FOR SALE

1 used 205 h.p. Keeler water tube boiler in excellent condition complete with re-built Auburn stoker automatic draft controls and new 5/16" thick 100 foot stack. Prssure relief valves set at 150 pounds guaranteed hydrostatic test of 240 pounds. Subject to prior sale.

**MIDDLETOWN MILK & CREAM CO., INC.**
**Delaware County, Frasers, New York**

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**NON-CONDENSING STEAM TURBINE GENERATOR UNIT**

500 KVA—3/60/480 volt Allis generator gear connected to a Terry turbine, 325 PSI, 110# gauge back pressure, REBUILT — EXCEPTIONAL BARGAIN.

**EUCLID ENGINEERING CORPORATION**
**609 National City East Sixth Building**
**Cleveland 14, Ohio**

### TRANSFORMERS—60 CYCLE

| Qu | KVA | Make | Type | Phase | Voltages |
|---|---|---|---|---|---|
| 2 | 3000 | Moloney | TCR | 3 | 7200/6600-4160/2400 |
| 2 | 750 | G.E. | K | 1 | 4600-120/240 |
| 1 | 750 | G.E. | KT | 3 | 4150Y-208/416 |
| 1 | 600 | West. | Power Ctr. | 3 | 2400-120/240/480 |
| 3 | 500 | West. | SL | | 4800/2400-240/480 |
| 1 | 300 | West. | Power Ctr. | 3 | 2400/4160Y/240-480 |
| 1 | 300 | Penna. | (Askarel) | 3 | 12470Y/7200-240 |
| 2 | 250 | G.E. | H Pyranol | 1 | 4800/8320Y/120/240 |
| 2 | 250 | West. | | 1 | 2300/4600-230/460 |
| 1 | 225 | Kuhlman | OISC Furn. | 1 | 440-100 |
| 3 | 200 | G.E. | H | 1 | 7800-15600-220/440 |
| 1 | 150 | Eisler | OA | 1 | 4160-240/480 |
| 3 | 100 | G.E. | H | | 2400/4160-240/480 |
| 3 | 50 | G.E. | HS | 1 | 2400/4160/240/120 |
| 1 | 50 | Amer. | Absetol | 3 | 4160-120/208Y |
| 3 | 50 | G.E. | HS | 1 | 2400/4160-240/480 |
| 3 | 37½ | West. | (Air) VR | 1 | 480/240-240/120 |
| 3 | 37½ | West. | S | 1 | 2400/4160Y/120/240 |
| 4 | 25 | West. | Hypersil | 1 | 2400/4160-120/240 |
| 3 | 15 | West. | H Pyranol | 1 | 6900/11950Y-120/240 |

### MOTOR GENERATOR SETS

| Qu | KW | Make | Speed | DC | AC |
|---|---|---|---|---|---|
| 3 | 60 | E.M. | 1200 | 125 | 220 v. Syn. |
| 1 | 75 | G.E. | 1200 | 125 | 2300/4160 Syn. |
| 2 | 100 | West. | 1200 | 250 | 2300/4160Y Syn. |
| 1 | 175 | West. | 1200 | 125 | 4150 Syn. |
| 1 | 300 | G.E. | 1200 | 250 | 2300/4160Y S.R. |
| 1 | 300 | G.E. | 1200 | 250 | 440 Sync. |
| 1 | 1000 | West. | 720 | 600 | 2300/4160Y |

### ENGINE GENERATOR SETS

1—Hercules Gas EXE 62.5 KVA Westghe 3/60/480—1200

1—Wisconsin Gas (Air) PE-99 7.5 KVA Master 1 or 3/120—2200 r.p.m. NEW.

### SLIP RING MOTORS

| Qu | HP | Make | Speed | Type | Volts |
|---|---|---|---|---|---|
| 2 | 40 | West. | 690 | CW | 220/440 |
| 1 | 60 | G.E. | 1800 | MT | 220 |
| 1 | 75 | G.E. | 600 | IM | 440 |
| 2 | 100 | West. | 1800 | T.E.F.C. B.B. | 220 |
| 3 | 150 | Allis-Ch. | 1800 | AY-RW | 2300 |
| 1 | 200 | West. | 514 | CW | 440 |
| 1 | 250 | West. | 600 | CW | 440 |
| 1 | 350 | West. | 1800 | CW | 2300 |
| 1 | 500 | G.E. | 450 | MT | 2200 |
| 1 | 500 | G.E. | 1200 | M569Z | 2300/4160Y |

### EXPLOSION PROOF

1—30 HP Louis Allis 444—BB—1200 r.p.m. 3/60/220/440

### D.C. MOTORS—230 VOLTS

| Qu | HP | Make | Speed | Type |
|---|---|---|---|---|
| 1 | 75 | Cr. Wh. | 860 | WP 53 H |
| 1 | 75 | Star | 1200 | SB 60 L B.B. |
| 1 | 350 | G.E. | 1200 | Pedestal |

### SQUIRREL CAGE MOTORS, 3 PHASE, 60 CYC.

1—300 HP, 1800 RPM, Gen. Elec. Type K, Fr. 6336S, 4150V

1—275 HP, 1180 RPM, Gen. Elec. Type KT, Fr. 559BS, 2200V

2—200 HP, 1790 RPM, Gen. Elec. KF, TEFC, 2300V

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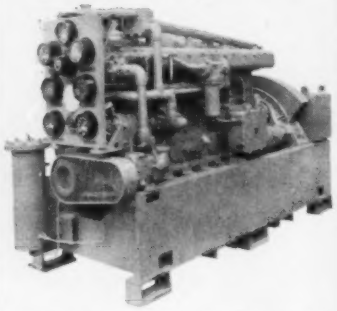
## 100 KW SUPERIOR 3-WIRE 120/240 V.D.C. DIESEL GENERATOR SETS

***Unused — In Original Crates***



Heat exchanger cooled Superior GBD-8 4-cycle diesel engine, 5½" bore — 7" stroke — 1200 RPM — 1330.4 cubic inch displacement — brake HP 152. GENERATOR: Delco 3-wire 100 KW — 120/240 volts DC — 417 amps — stab. shunt wound — self-excited — complete with balance coil. Full 100 KW output at 240 volts. SPECIFICATIONS: Fuel consumption 0.620 lbs/KW hr. — weight 10,000 lbs. — 124" overall length — 65 11/16" high — height necessary to pull piston 67⅝". Units complete with muffler, flexible pipe, thermometers, etc.

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**313 E. BALTIMORE STREET**
**BALTIMORE 2, MD. ELgin 5-5050**

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### HIGH PRESSURE BOILER

30,000 pound steam per hour Combustion Engineering boiler, type VU, two drum, bent tube, 450# steam pressure, 825° FTT, complete with spreader stoker and automatic control.

*New 1950—Excellent Condition*

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7/58

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250 KVA
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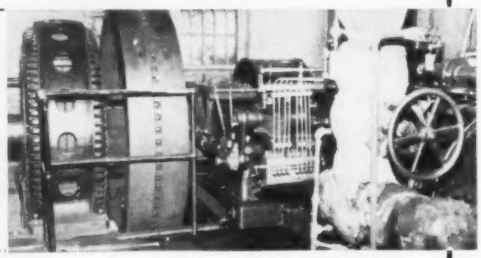
Produces 440 Volts 3 Phase 60 Cycle. We can change to 220. Requires 140 to 150 lbs. steam pressure.



**GOOD CONDITION — too small for our use**

*Above can be inspected* at our plant in operation

Will load on cars by Skinner Engine Co.

*We will include* exciter, meter, controls, for regulating current.

Also some 6" steam pipe.

DON'T MISS THIS OPPORTUNITY

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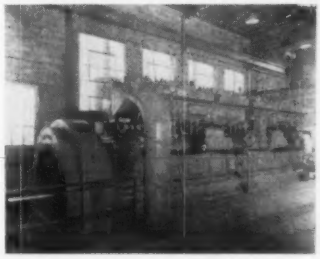
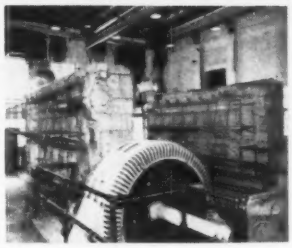


- New 1948
- Less than 15,000 hours total operation
- Will convert to dual fuel

**1000 KW SUPERIOR—MODEL 80SX—Located Tavernier, Fla.**



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100 KW to 1500 KW

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with direct connected exciter. 200 RPM—220 Volts, 60 Cycle, 3 phase complete with switchboard, driven by a Chuse Uniflow engine which has just been overhauled. This was a standby for us but it has become too small.

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600 HP—720 RPM, General Motors Model 567 Electro Motive Diesel engine direct connected to a:

500 KVA—400 KW at 80% PF, 720 RPM, 3 phase 60 cycle, 480 volt Westinghouse alternating current generator.

Complete installation. Equivalent to new.

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Box 661 Moultrie, Ga.

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Bates Corliss Engine 820 Indicated H.P., outboard bearing, 24" by 48" Bore & Stroke, w/500 KW Generator. 100 RPM. 16 Foot Flywheel. This excellent machine completely overhauled in 1945 and has been used as standby only. Contact

**PAUL OBERMAN**
GA 1-1910 1910 Delmar, St. Louis 3, Mo.

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Diesel Generator Units, 200 KW-1500 KW — Turbo Generators, 500 KW-10,000 KW
Motor Generator Sets—Rotary Converters—Synchronous Condensers—
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**UTILITIES MACHINERY CORPORATION**

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**Wilmington, Delaware**

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| 200′ | 4″ | Sch | 80 — Gr P1 |
| 25′ | 6″ | Sch | 40 — Gr P1 |
| 180′ | 8″ | Sch | 40 — Gr P1 |
| 23′ | 8″ | Sch | 30 — Gr P1 |
| 422′ | 3″ | Sch | 160 — Gr P2 |
| 51′ | 4″ | Sch | 120 — Gr P2 |
| 110′ | 6″ | Sch | 40 — Gr P2 |
| 67′ | 8″ | Sch | 40 — Gr P2 |
| 22′ | 10″ | Sch | 100 — Gr P2 |
| 20′ | 16″ | Sch | 100 — Gr P2 |
| 68′ | 2½″ | Sch | 40 — Gr P5 |
| 140′ | 2½″ | Sch | 80 — Gr P5 |
| 87′ | 3″ | Sch | 40 — Gr P5 |
| 200′ | 3″ | Sch | 80 — Gr P5 |
| 200′ | 4″ | Sch | 40 — Gr P5 |
| 160′ | 4″ | Sch | 80 — Gr P5 |
| 33′ | 6″ | Sch | 40 — Gr P5 |
| 25′ | 6″ | Dble Ex Hy | — Gr P5 |
| 17′ | 6″ | Sch | 160 — Gr P5 |
| 110′ | 8″ | Sch | 40 — Gr P5 |
| 113′ | 8″ | Sch | 80 — Gr P5 |
| 12′ | 8″ | Sch | 160 — Gr P5 |
| 187′ | 10″ | Sch | 60 — Gr P5 |
| 300′ | 2½″ | Sch | 80 — Gr P11 |
| 550′ | 3″ | Sch | 40 — Gr P11 |
| 460′ | 3″ | Sch | 80 — Gr P11 |
| 340′ | 3″ | Sch | 160 — Gr P11 |
| 85′ | 4″ | Sch | 40 — Gr P11 |
| 600′ | 4″ | Sch | 80 — Gr P11 |
| 120′ | 4″ | Sch | 160 — Gr P11 |
| 47′ | 4″ | Dble Ex Hy | — Gr P11 |
| 23′ | 5″ | Sch | 160 — Gr P11 |
| 70′ | 6″ | Sch | 40 — Gr P11 |
| 440′ | 6″ | Sch | 80 — Gr P11 |
| 1800′ | 6″ | Sch | 160 — Gr P11 |
| 50′ | 6″ | Dble Ex Hy | — Gr P11 |
| 300′ | 8″ | Sch | 40 — Gr P11 |
| 1070′ | 8″ | Sch | 80 — Gr P11 |
| 1345′ | 8″ | Sch | 160 — Gr P11 |
| 41′ | 8″ x 1.264″ Nom. Wall | | — Gr P11 |
| 25′ | 8″ x 1.25″ Nom. Wall | | — Gr P11 |
| 1080′ | 10″ | Sch | 60 — Gr P11 |
| 1076′ | 10″ | Sch | 80 — Gr P11 |
| 28′ | 10″ | Sch | 120 — Gr P11 |
| 43′ | 10″ | Sch | 160 — Gr P11 |
| 53′ | 10″ x 1.563″ Nom. Wall | | — Gr P11 |
| 95′ | 12″ | Sch | 80 — Gr P11 |
| 95′ | 12″ | Sch | 100 — Gr P11 |
| 24′ | 12″ | Sch | 120 — Gr P11 |
| 324′ | 14″ | Sch | 80 — Gr P11 |
| 22′ | 14″ x 1-13/16″ Nom. Wall | | — Gr P11 |
| 170′ | 16″ | Sch | 80 — Gr P11 |
| 33′ | 18″ | Sch | 100 — Gr P11 |
| 17′ | 24″ x ¾″ Nom. Wall | | — Gr P11 |
| 68′ | 3″ | Sch | 160 — Gr P12 |
| 20′ | 5″ | Sch | 40 — Gr P12 |
| 180′ | 5″ | Sch | 160 — Gr P12 |
| 27′ | 6″ | Sch | 80 — Gr P12 |
| 31′ | 8″ | Sch | 100 — Gr P12 |
| 55′ | 8″ | Sch | 20 — Gr P12 |
| 22′ | 8″ | Sch | 40 — Gr P12 |
| 54′ | 10″ x 7/16″ Nom. Wall | | — Gr P12 |
| 33′ | 24″ | Sch | 40 — Gr P12 |
| 225′ | 3″ | Sch | 80 — Gr P22 |
| 780′ | 4″ | Sch | 40 — Gr P22 |
| 86′ | 4″ | Sch | 80 — Gr P22 |
| 50′ | 6″ | Sch | 80 — Gr P22 |
| 46′ | 6″ x 1.10″ Nom. Wall | | — Gr P22 |
| 330′ | 8″ | Sch | 80 — Gr P22 |
| 12′ | 8″ x 1.212″ Nom. Wall | | — Gr P22 |

All items in stock subject to prior sale. Mill test reports furnished on request. For further information and prices . . . to place your order . . . contact

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Warehouse Division

2nd & Lombard Streets

Wilmington, Delaware

Telephone: OLympia 8-7181

*Dependable piping fabrication and installation since 1893*

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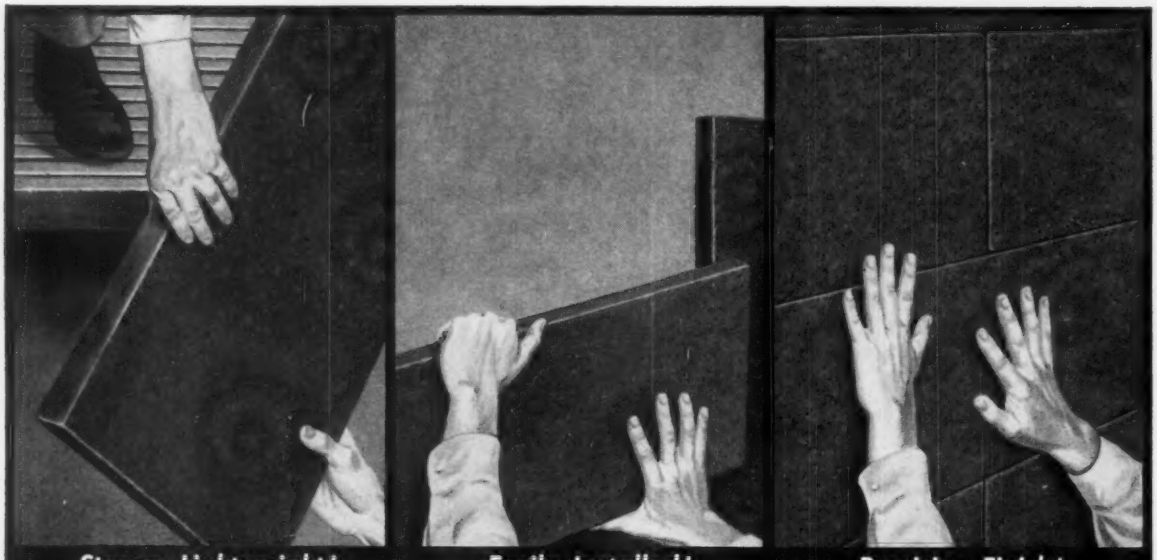
# A TRUE-CUT BLOCK WITH PRECISION-FINISH!

## EAGLE-PICHER

# PV SUPERTEMP
## BLOCK INSULATION



*Strong, Lightweight!* *Easily Installed!* *Precision Finish!*

- Eagle-Picher's "precision-finish" is one of the most important insulation developments in years.
- Highly efficient, all-purpose block that is practically dustless.
- Great structural strength! Meets rigid demands for long-lasting block able to withstand wide temperature range up to 1900 F.
- Lightweight, easily installed! Easily cut to fit irregular areas—no special tools needed. Requires only minimum reinforcing.
- Effectively resists steam and other moisture! Does not disintegrate or lose thermal efficiency under heavy duty service.

*Eagle-Picher produces a complete line of industrial insulations for all temperatures from below Zero to over 2000 F.*

**FREE SAMPLE!**

**Write Today!**

Eagle-Picher PV Supertemp Block conforms to Commercial Standard CS 117.

*Since 1843*

EAGLE PICHER

## EAGLE-PICHER

The Eagle-Picher Company • General Offices: Cincinnati 1, Ohio

(*Member of Industrial Mineral Fiber Institute*)

BULLETIN No. BJP-58-8

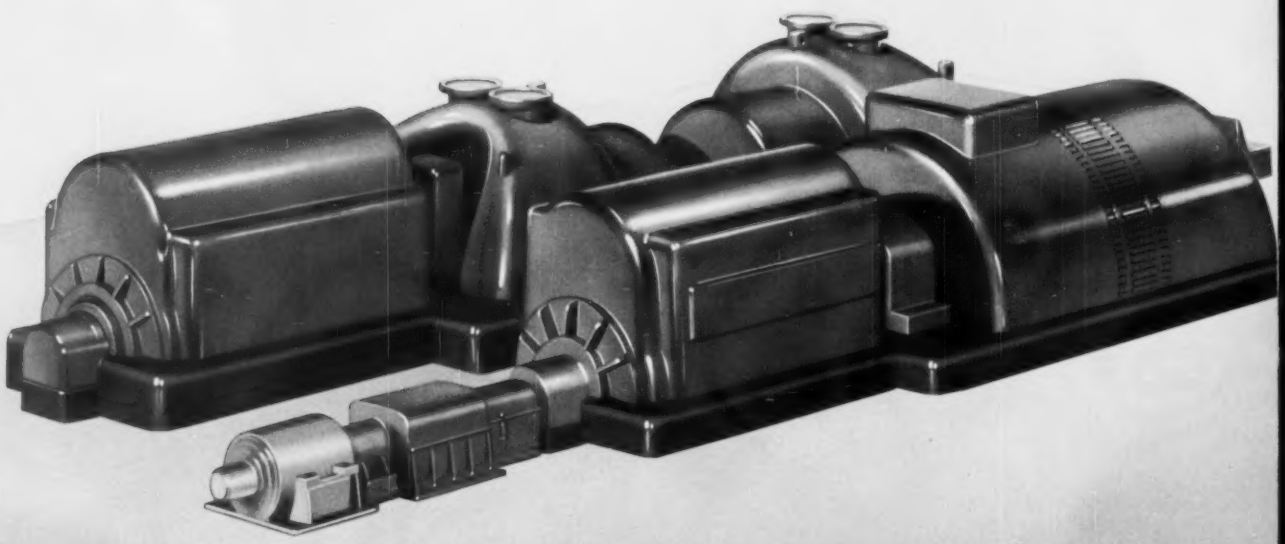
# BJ Power Plant Pumps

A PUMP FOR EVERY POWER PLANT NEED

- BOILER FEED DUTY
- CONDENSATE PUMPS
- CIRCULATING PUMPS
- STATION AUXILIARY PUMPS
- SPECIAL DESIGNS
- NUCLEAR FLUIDS

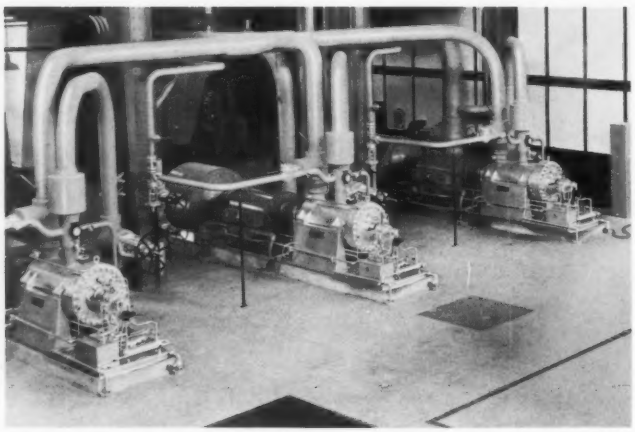
# BJ

*...one reliable source for all power pumping requirements*



## 12,000 hp, 3600 rpm Double-Case Boiler Feed Pump

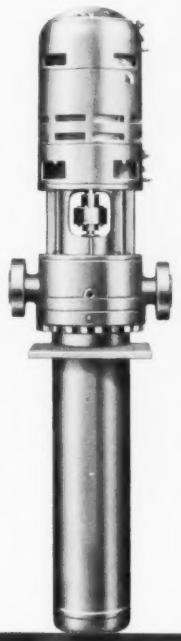
Typical of the advanced engineering and design of Byron Jackson pumps is this unusual double-case, high-pressure boiler feed pump. Through a unique arrangement the pump is directly driven from the main generator shaft. It will deliver feed water at 6330 gpm against a 6400 foot total dynamic head.



**DOUBLE CASE BOILER FEED PUMP** – Reliability, simplicity and ease of maintenance have been emphasized in this BJ design. The result is a highly efficient pump in which complete confidence can be placed. Sizes and capacities are available as required.

### VERTICAL DOUBLE CASE PUMP

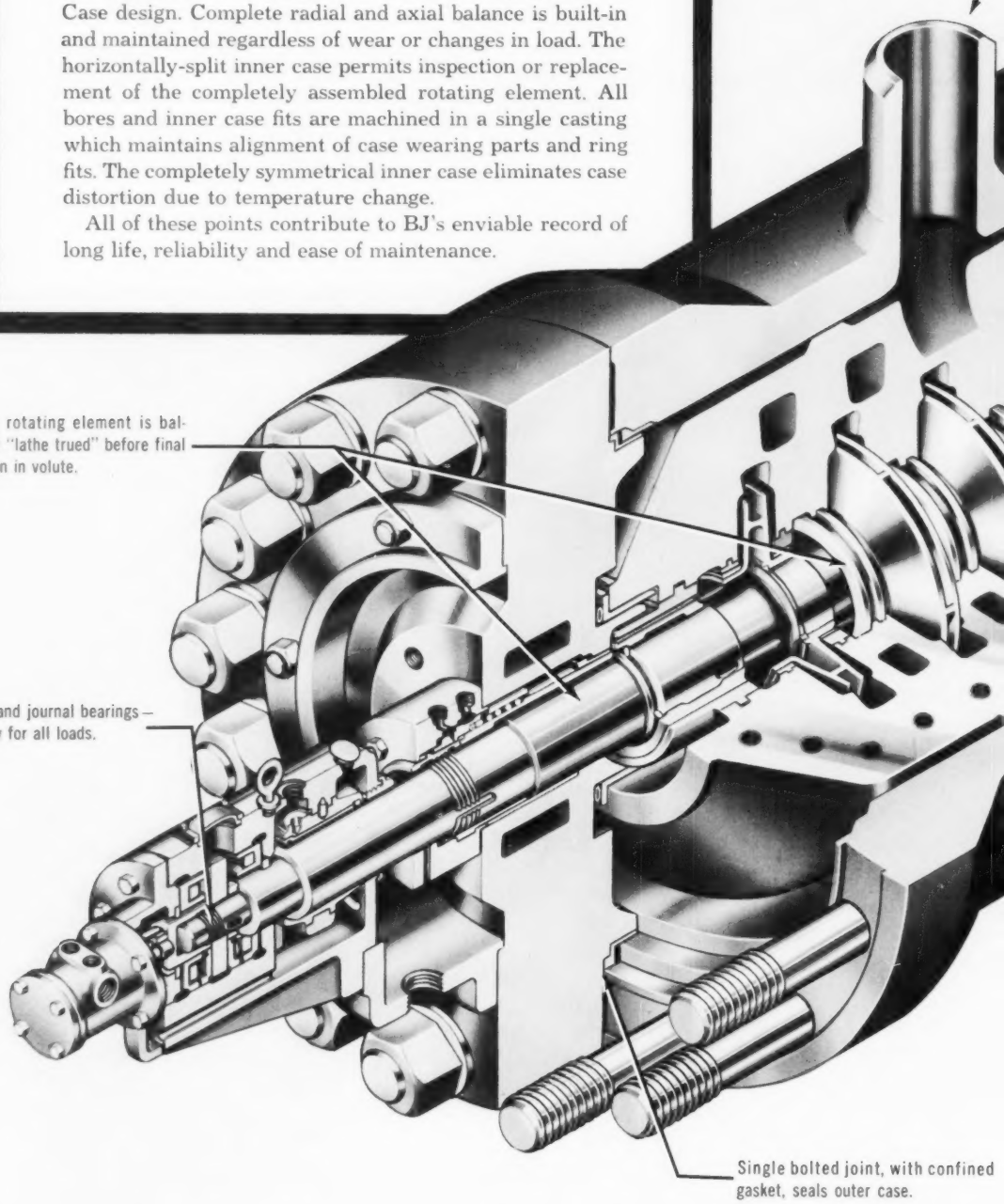
The advantages of the double-case design are featured in this compact, vertical pump. For high-pressure, high-speed with low capacity, or operated in series of two or more for higher performance. Capacities are from 20 to 500 gpm with heads from 50 to 500 feet per stage (to 5000 psi).



# the **BJ** Double-Case Boiler Feed design

Several distinct advantages are inherent in the BJ Double Case design. Complete radial and axial balance is built-in and maintained regardless of wear or changes in load. The horizontally-split inner case permits inspection or replacement of the completely assembled rotating element. All bores and inner case fits are machined in a single casting which maintains alignment of case wearing parts and ring fits. The completely symmetrical inner case eliminates case distortion due to temperature change.

All of these points contribute to BJ's enviable record of long life, reliability and ease of maintenance.


Suction and discharge nozzles are available to customer's specifications.
Complete rotating element is balanced and "lathe trued" before final installation in volute.
Sturdy thrust and journal bearings — ample capacity for all loads.
Single bolted joint, with confined gasket, seals outer case.

les
r's

Double suction first stage impeller permits operation at minimum NPSH.

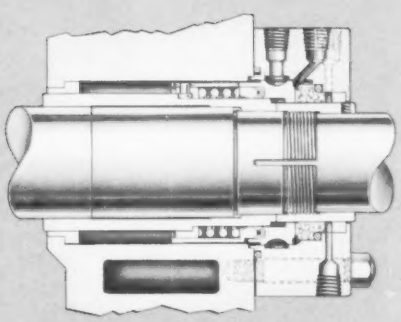
Water-jacketed BJ Mechanical Seals save treated feed water and BTU's usually lost through gland leakage—eliminate packing maintenance and shaft sleeve replacement.

Horizontally-split inner volute permits inspection, removal, or replacement of rotating element as an assembled unit. All fits available for quick inspection.

Volute design accommodates uniform temperature expansion encountered in emergency start up.

Impellers mounted in equally opposed groups for hydraulic axial balance. Double volute assures radial balance.

fined

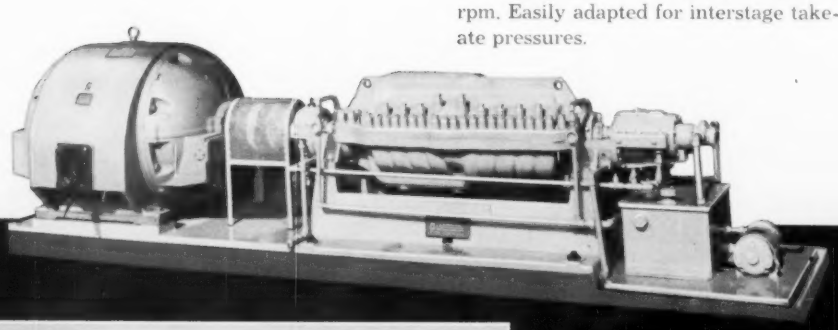


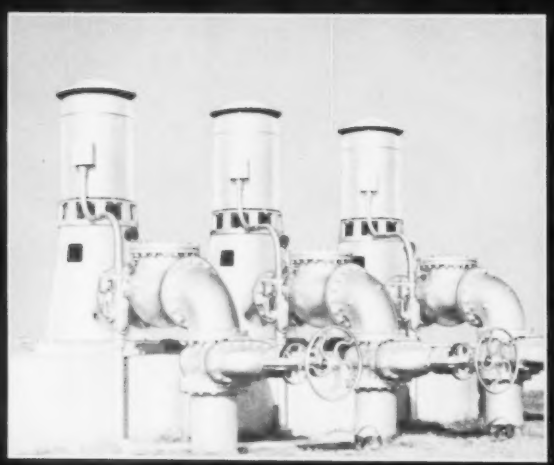
PATENT NO. 2,824,759

## BJ MECHANICAL SEALS FOR POWER PLANT SERVICE

Especially designed for sealing against the high pressures and temperatures of power plant service, BJ Mechanical Seals are recommended for all pumps. On the type D Seal shown here, the rotating face incorporates a pumping ring for circulating cooled liquid to the seal faces. In addition, water jacketing is provided to prevent temperature damage while unit is on standby.

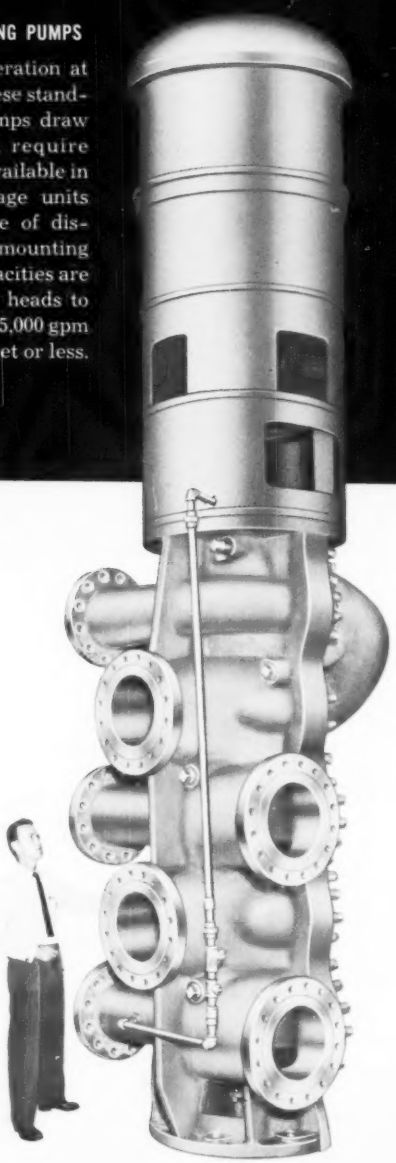
**DVMX PUMPS**—A proven, split-case boiler feed pump with double row bolting to prevent interstage leakage or bowing at parting flanges. Compact, symmetrical design allows safe operation to 500° F. . . hydraulic pressures to 4000 psi . . . metallurgy and construction permits speeds to 7000 rpm. Easily adapted for interstage take-off at intermediate pressures.

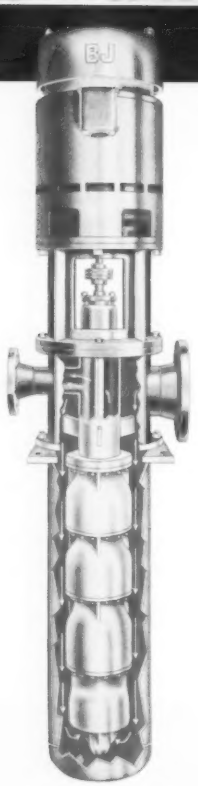




### VERTICAL CIRCULATING PUMPS

For continuous operation at high efficiencies, these standard circulating pumps draw from a sump and require little floor space. Available in single or multi-stage units with a wide choice of discharge column and mounting arrangements. Capacities are to 24,000 gpm with heads to 500 feet, and up to 45,000 gpm with heads of 250 feet or less.



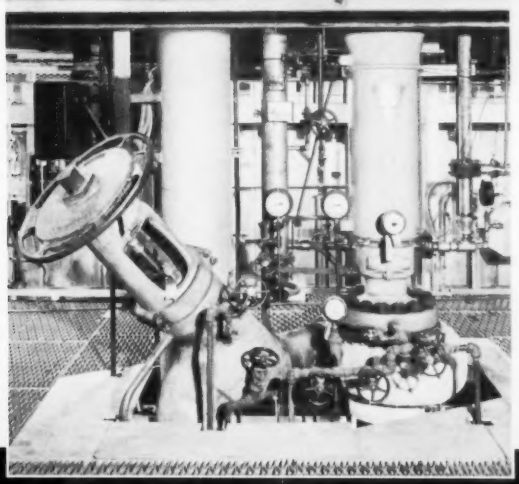


### VERTICAL CONDENSATE PUMPS

Ideal for pumping liquids near the boiling point, or for any application where NPSH is limited. This multi-stage, vertical pump is a self-contained unit mounted in a barrel which creates its own suction sump. Requires minimum floor space. Standard models have capacities up to 2000 gpm with heads as required.

### SPECIAL POWER PUMP DESIGNS

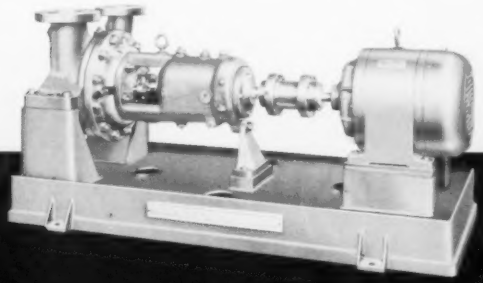
Always first in the development of improved designs and greater pump efficiency, Byron Jackson can engineer and build special pumps for any requirements. Shown here is a 4 in 1 condensate pump which uses one driver for four pumps. This common shaft arrangement saves floor space and provides added reliability with only one stuffingbox necessary.



**BOILER RECIRCULATING PUMP**—The BJ Electro-mersible, shown here, operates under full boiler pressures and temperatures to provide efficient circulation for peak boiler performance. Vertical design with a heat barrier and wet-winding motor eliminates the use of a stuffingbox. Suction pressures 2000 psig and above, water temperatures to 658° F. Capacity is 6970 gpm with a 124 foot head and up to 10,000 gpm at reduced head pressures.

### SM PUMPS

A heavy-duty process type pump for use in condensate and light boiler recirculation duty. Easily dismantled for inspection without disturbing major piping. Single and double stage models available for a wide range of pressures and at temperatures to 800° F. Capacities are to 3800 gpm, heads to 1600 feet.



### HIGH SPEED RECIRCULATING PUMPS

This combination feed and booster pump is an example of BJs advanced leadership in pump engineering. Weight, space and NPSH were all critical design factors in this pump which operates at 15,800 rpm.

### BJ PUMPS FOR NUCLEAR POWER APPLICATIONS

This giant BJ Liquid Sodium Pump is used for primary cooling in a nuclear fueled power plant. Standing 35 feet and with a 6 foot diameter, it is rated at 1,000 hp and delivers liquid sodium at 1000° F, at 11,800 gpm with a 310 foot head! BJ designs and manufactures all types and sizes of pumps and mechanical seals for nuclear fluids.

Whatever your pump requirements for power plant service, Byron Jackson can furnish the best equipment for the job, and is backed by over 86 years experience in design and manufacture of quality pumps. Detailed performance and specification information is available on the pumps shown here from your nearest BJ office.

*Since* **BJ** *1872*

# BYRON JACKSON PUMPS

INCORPORATED

A Subsidiary of Borg-Warner Corporation

BOX 2017A, TERMINAL ANNEX • LOS ANGELES 54, CALIFORNIA

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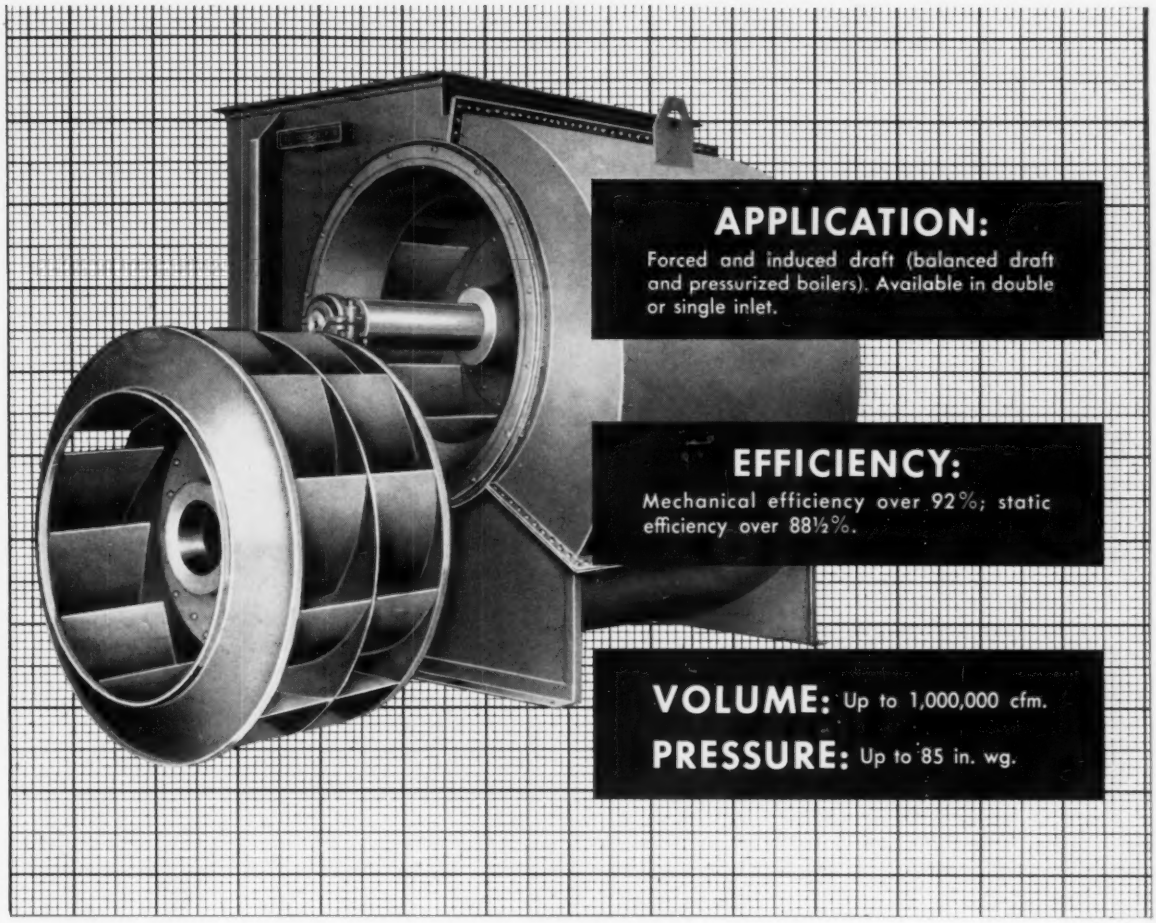
# AMERICAN BLOWER AIRFOIL FANS


APPLICATION:
Forced and induced draft (balanced draft and pressurized boilers). Available in double or single inlet.
EFFICIENCY:
Mechanical efficiency over 92%; static efficiency over 88½%.
VOLUME: Up to 1,000,000 cfm.
PRESSURE: Up to 85 in. wg.

If you're thinking "airfoil" on your next mechanical-draft installation, think of American Blower.

For, the advanced design of American Blower Airfoil Fans provides a smooth interworking of properly designed housing, streamline inlets, and wheel component parts — which results in higher efficiency, lower power consumption. The nonoverloading horsepower characteristic makes it possible to select a driving motor close to the fan horsepower.

**Team this fan** with American Blower *Gyrol*® Fluid Drive and you have a unit which gives high efficiency with low operating cost — plus quieter operation over the full operating range, and longer life of the critical fan parts. In addition, a motor with standard $WR^2$ capacity is all that is required, because of low starting inertia.

**Why not talk** to an American Blower sales engineer about *your* requirements. His knowledge of air-handling equipment can prove invaluable to you. Call our nearest branch office, or write: American-Standard,* American Blower Division, Detroit 32, Michigan. In Canada: Canadian Sirocco products, Windsor, Ontario.

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American-Standard Products

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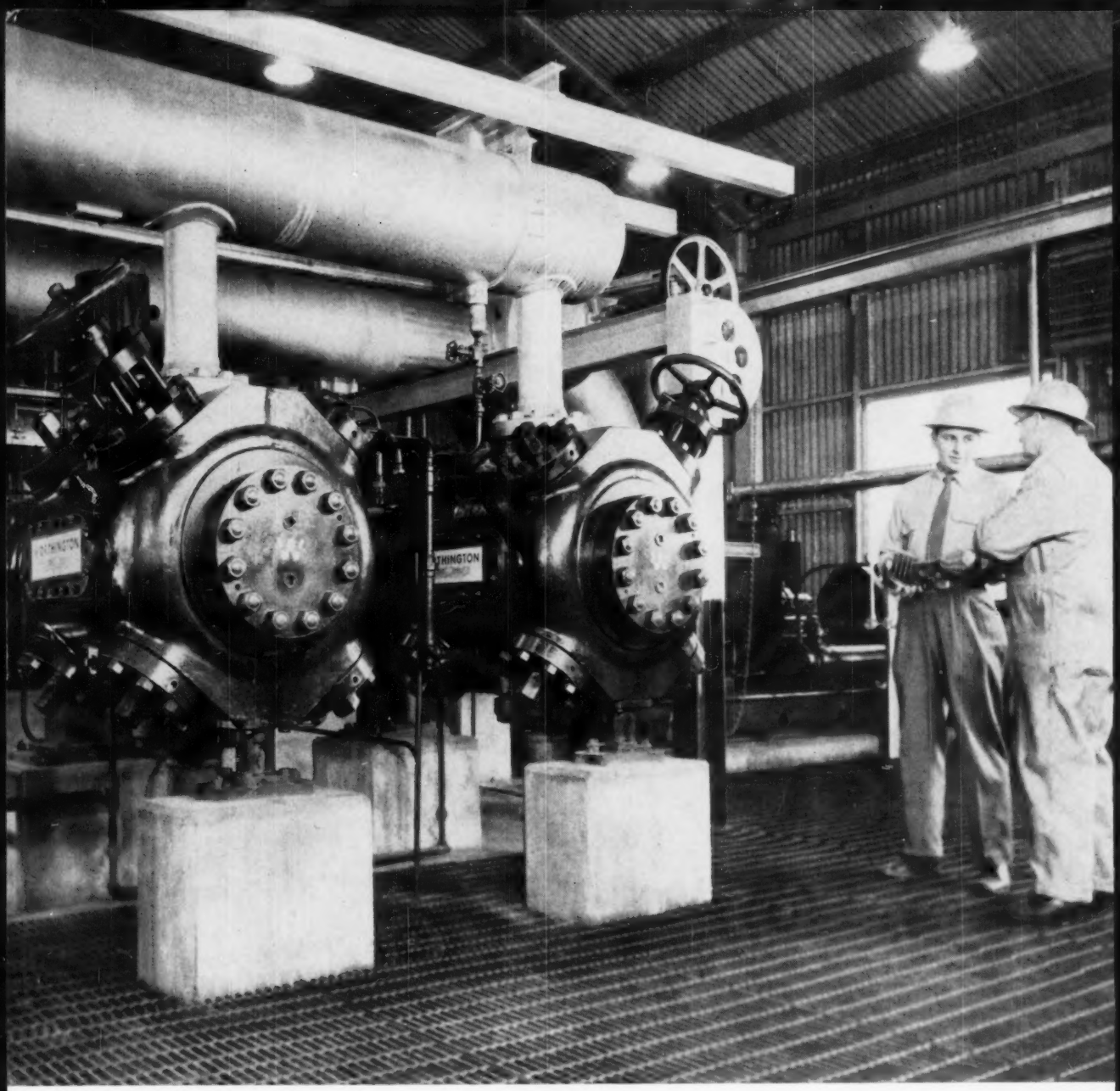

## compressor-user survey shows

# FEATHER VALVE PREFERRED 2 TO 1!

FEATHER VALVE

VALVE A

VALVE B

A recent survey of compressor users put the amazing Feather Valve* first by far in all four operating categories —simplicity of construction, efficiency, low maintenance cost and quiet operation. In addition, the Feather Valve was picked as the preferred compressor valve 2 to 1 over the nearest competing type of valve!

The lightest, fastest-acting valve available, the amazing Feather Valve provides very sharp action with virtually no slip or back-flow. It works with no impact . . . has no buffer plates or cushioning devices. Practically indestructible it assures long life with negligible maintenance costs. When buying your next compressor, look into Worthington's complete line of Feather Valve units. Worthington Corporation, Harrison, N. J. 30-3

*REG. U. S. PAT. OFF.

WORTHINGTON